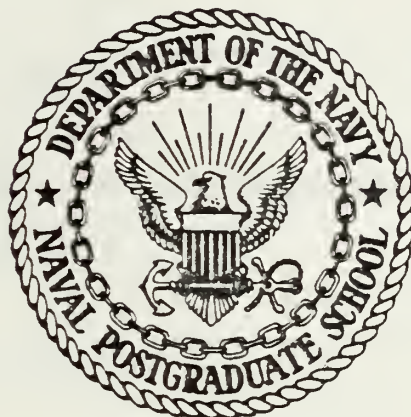


NAVAL WEAPONS STATION
CONCORD EXPORT CAPABILITY
A SIMULATION MODEL.

David C. Fountain

NAVAL POSTGRADUATE SCHOOL

Monterey, California



THESIS

NAVAL WEAPONS STATION, CONCORD
EXPORT CAPABILITY:
A SIMULATION MODEL

by

David C. Fountain

June 1977

Thesis Advisor:

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A SIMULATION MODEL

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Captain, United States Army
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Submitted in partial fulfillment of the
requirements for the degree of

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from the
NAVAL POSTGRADUATE SCHOOL

June 1977

ABSTRACT

This paper represents an analysis of the ocean ammunition export function of the Naval Weapons Station at Concord, California. The analysis, utilizing the general purpose transportation simulator TRANSIM, defines the system and adapts it to TRANSIM notation. The objective of the project was to establish a workable model and use it to predict the maximum export capability of NWS, Concord. Five simulations were completed; three replicated the historical data to establish the model's workability and the other two indicated increased capabilities possible.

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TABLE OF CONTENTS

I.	BACKGROUND.....	11
II.	INTRODUCTION.....	13
III.	INTENT OF THE PROJECT.....	17
IV.	ASSUMPTIONS.....	19
V.	THE NAVAL WEAPONS STATION, CONCORD TIDAL AREA....	21
	A. PLANNING CONSIDERATIONS.....	21
	B. VAN AND RAILCAR MOVEMENT PROCEDURES.....	22
	C. AREA CAPABILITIES.....	23
	D. OPERATING TIMES.....	26
VI.	THE TRANSIM VIEW OF NWS, CONCORD.....	28
	A. SYSTEM BOUNDARIES.....	28
	B. BASIC ELEMENTS OF THE MODEL.....	29
	C. ALTERNATIVE APPROACHES.....	31
	D. DATA ELEMENTS.....	33
	1. Capacity Elements.....	33
	2. Time Elements.....	34
	E. SYSTEM SUMMARY.....	37
VII.	THE DERIVATION OF THE PARAMETERS.....	39
	A. PARAMETERS HELD CONSTANT.....	39
	B. PARAMETERS TO BE VARIED IN SIMULATIONS.....	39
	1. Distribution of Vessel Classes.....	41
	2. Vessel Class Berth Times.....	43
	3. Vans and Railcars per Vessel Class.....	47
	4. Unloading Times of Vans and Railcars.....	48
	5. Interarrival Time for Trains.....	49
	6. Interarrival Time of Vessels.....	49
	7. Interarrival Times for Trucks.....	50
	8. Number of Railcars per Trains.....	51
VIII.	RESULTS.....	52
IX.	CONCLUSIONS.....	57

X. RECOMMENDATION.....	59
Appendix A: OPERATING RULES OF THE MODEL.....	60
Appendix B: SAMPLE OPERATING RULES.....	64
Appendix C: INITIAL SITUATION IN THE MODEL.....	72
Appendix D: ITERATIVE PROCESS OF TRANSIM.....	74
Appendix E: RESULTS OF SIMULATION RUN I.....	82
Appendix F: RESULTS OF SIMULATION RUN II.....	93
Appendix G: RESULTS OF SIMULATION RUN III.....	104
Appendix H: RESULTS OF SIMULATION RUN IV.....	115
Appendix I: RESULTS OF SIMULATION RUN V.....	126
Appendix J: VESSEL EXPORT TONNAGES IN CLASS GROUPINGS FOR JANUARY THROUGH JUNE 1968.....	137
Appendix K: THE TRIANGULAR DISTRIBUTION.....	139
LIST OF REFERENCES.....	140
BIBLIOGRAPHY.....	141
INITIAL DISTRIBUTION LIST.....	143
LIST OF FIGURES.....	7

LIST OF FIGURES

1. Generalized System.....	14
2. Map of NWS, Concord Tidal Area.....	25
3. Detailed Schematic.....	30
4. Vessel Class Distribution.....	40
5. Berth Times by Vessel Class.....	42
6. Actual vs. Simulated Tons per Vessel Class.....	44
7. Actual and Theoretical Numbers of Vans and Railcars per Vessel Class.....	46
8. Composite Results.....	55
9. Actual Numbers of Vessels in Each Class for Each Simulation.....	56
10. Sample Operating Rules Input.....	65
11. Sample Operating Rules Input (cont.).....	66
12. Sample Operating Rules Input (cont.).....	67
13. Sample Operating Rules Input (cont.).....	68
14. Sample Operating Rules Input (cont.).....	69
15. Sample Operating Rules Input (cont.).....	70
16. Sample Operating Rules Input (cont.).....	71
17. Initial Data in the Model.....	73
18. Sample TRANSIM Iterations.....	76
19. Sample TRANSIM Iterations (cont.).....	77

20.	Sample TRANSIM Iterations (cont.)	78
21.	Sample TRANSIM Iterations (cont.)	79
22.	Sample TRANSIM Iterations (cont.)	80
23.	Sample TRANSIM Iterations (cont.)	81
24.	Occupancy of All Berths (Sim. I)	84
25.	Total Truck Cargo Exported (Sim. I)	85
26.	Total Rail Cargo Exported (Sim. I)	86
27.	Ship Time at All Berths (Sim. I)	87
28.	Ship Delay Times (Sim. I)	88
29.	Number of Vans in Storage Areas (Sim. I)	89
30.	Storage Times of Vans (Sim. I)	90
31.	Number of Trains at Storage Area (Sim. I)	91
32.	Storage Times of Railcars (Sim. I)	92
33.	Occupancy of All Berths (Sim. II)	95
34.	Total Truck Cargo Exported (Sim. II)	96
35.	Total Rail Cargo Exported (Sim. II)	97
36.	Ship Time at All Berths (Sim. II)	98
37.	Ship Delay Times (Sim. II)	99
38.	Number of Vans in Storage Areas (Sim. II)	100
39.	Storage Times of Vans (Sim. II)	101
40.	Number of Trains at Storage Area (Sim. II)	102
41.	Storage Times of Railcars (Sim. II)	103
42.	Occupancy of All Berths (Sim. III)	106
43.	Total Truck Cargo Exported (Sim. III)	107

44.	Total Rail Cargo Exported (Sim. III)	108
45.	Ship Time at All Berths (Sim. III)	109
46.	Ship Delay Times (Sim. III)	110
47.	Number of Vans in Storage Areas (Sim. III)	111
48.	Storage Times of Vans (Sim. III)	112
49.	Number of Trains at Storage Area (Sim. III)	113
50.	Storage Times of Railcars (Sim. III)	114
51.	Occupancy of All Berths (Sim. IV)	117
52.	Total Truck Cargo Exported (Sim. IV)	118
53.	Total Rail Cargo Exported (Sim. IV)	119
54.	Ship Time at All Berths (Sim. IV)	120
55.	Ship Delay Times (Sim. IV)	121
56.	Number of Vans in Storage Areas (Sim. IV)	122
57.	Storage Times of Vans (Sim. IV)	123
58.	Number of Trains at Storage Area (Sim. IV)	124
59.	Storage Times of Railcars (Sim. IV)	125
60.	Occupancy of All Berths (Sim. V)	128
61.	Total Truck Cargo Exported (Sim. V)	129
62.	Total Rail Cargo Exported (Sim. V)	130
63.	Ship Time at All Berths (Sim. V)	131
64.	Ship Delay Times (Sim. V)	132
65.	Number of Vans in Storage Areas (Sim. V)	133
66.	Storage Times of Vans (Sim. V)	134
67.	Number of Trains at Storage Area (Sim. V)	135

68.	Storage Times of Railcars (Sim. V).....	136
69.	Vessel Export Tonnages in Class Groupings for January through June 1968.....	138
70.	A Triangular Distribution.....	139

I. BACKGROUND

The Naval Weapons Station (NWS), Concord is located in California about thirty-five miles northeast of San Francisco and seventy miles southwest of Sacramento. Although the station comprises three activities at sites near Concord, Pittsburg, and Vallejo, this study concerned itself with only the Concord activity.

Of the many missions assigned to NWS, Concord, only two have relevance to this study. The two missions that related directly to the export capability are the following:

1. Operate a munitions storage, maintenance and transshipment facility to support the operating forces:
 - A. Receive, renovate, maintain, store, and issue ammunition explosives, expendable ordnance items and/or weapons and technical ordnance material.
 - B. Operate and maintain an ocean terminal facility to transship ordnance material in support of the Armed Forces...
2. Provide logistics and port terminal services in support of Pacific Fleet Ammunition Ships (AES) homeported at the Station... [1-1].

Although NWS, Concord is a Navy owned and operated installation, by its rather unique position as the only major West Coast ammunition ocean terminal, it is required to support the other services and is thereby critical to the Department of Defense. The facility is strictly Naval but it does report for administration and accounting purposes to the Oakland Terminal of the Military Traffic Management Command, the Department of Defense agency responsible for worldwide traffic management. NWS, Concord is the ammunition counterpart of Oakland, the primary West Coast

general cargo port. (The Oakland facility is about twenty-five miles southwest of Concord.)

The facility at Concord is divided into the Inland Area and the Tidal Area. The Inland Area is concerned with research, administration, military housing, and similar activities, while the Tidal Area is concerned with the operational aspects of the transshipment of ammunition.

II. INTRODUCTION

The analysis of NWS, Concord's capabilities was accomplished by using as a basis the simulation model TRANSIM. TRANSIM is a general purpose transportation system simulator developed originally in 1966 by the Department of Engineering, University of California at Los Angeles (UCLA) for the Undersecretary of Transportation in the U.S. Department of Commerce. The continuing effort of the Project TRANSIM office at UCLA is to update and simplify the program, most recently published as TRANSIM IV.

TRANSIM is a modular approach to a transportation system model which can be utilized to model transportation networks, transfer facilities, and intermodal relationships including a marine/port complex. It is capable of utilizing either deterministic or probabilistic input data. Specific elements of TRANSIM as it applies to NWS, Concord are discussed in Chapter Six.

The input of ammunition was by two modes, truck and rail, and is recognized when the truck or the rail car "passes through the gate" and becomes available for handling by NWS, Concord. The ammunition is inspected, catalogued, and placed in storage until required for loading aboard a vessel. Empty vessels (partially loaded vessels from other ports were considered empty vessels throughout the analysis) enter the system through a harbor, and exit to the harbor after loading. A general schematic of the system elements is shown in Figure 1.

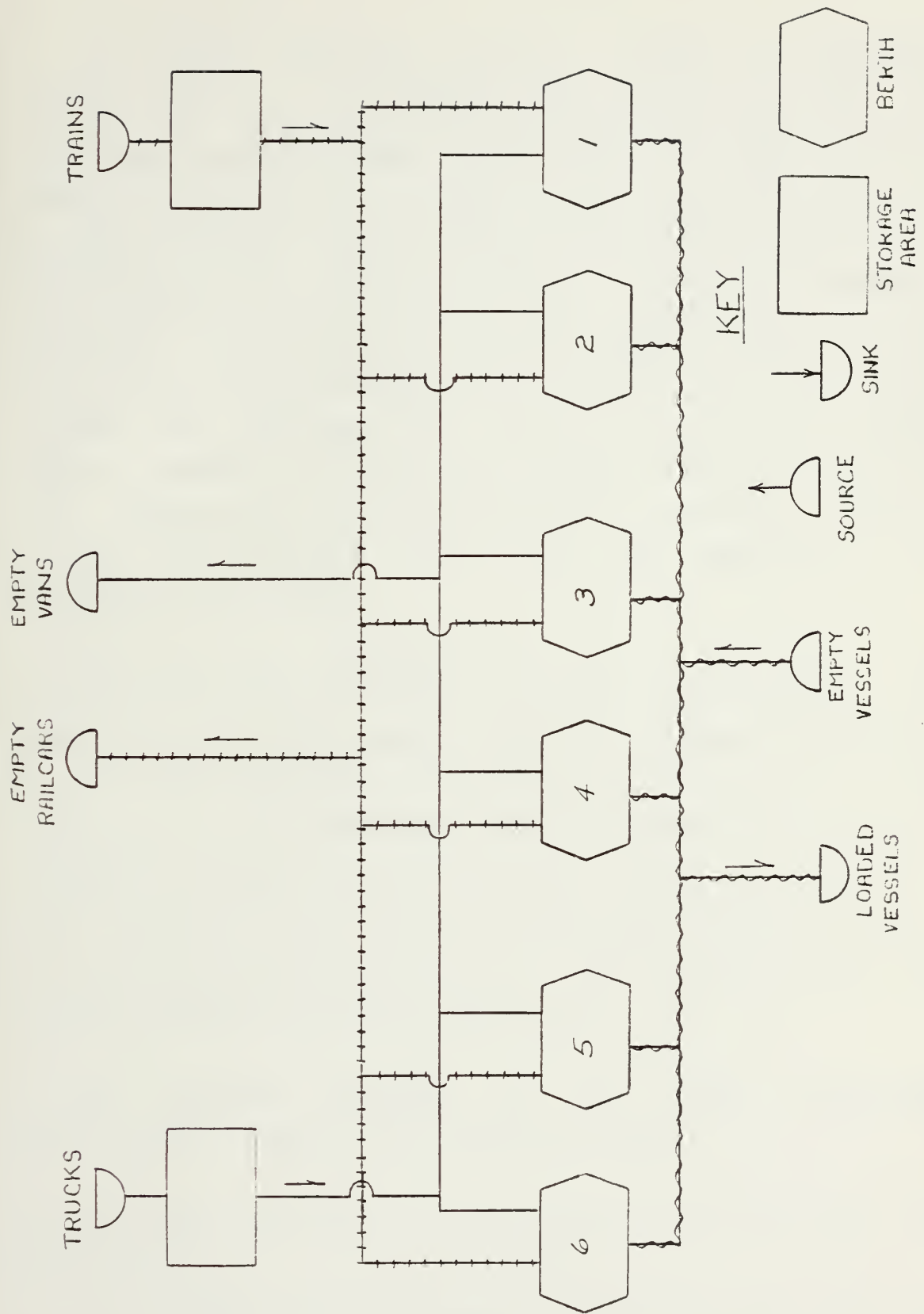


Figure 1 - GENERALIZED SYSTEM

The study considered only the export of ammunition aboard merchant marine type cargo vessels and did not provide for the handling of any waterborne imported cargo. This specifically excluded ship discharge operations and operations of the U. S. Navy vessels commonly referred to as AEs, which were found to be low productive factors in the historical data. Since the AEs are homeported at Concord, this restriction may not have been completely realistic. Therefore, toward the end of the analysis consideration was given to the probable presence and needs of AEs, and these vessels are discussed as a part of the system in Chapter Eight. However, to achieve the maximum export capability of NWS, Concord, the AEs were considered a negative influence, as will be explained later, and were excluded in the building of the model.

The study was restricted in one notable area. All computer simulations were processed with the computer at UCLA, where the most current version of TRANSIM is stored on tape. The complexity of the program did not allow for the program to be transferred to another computer site without a significant TRANSIM training program involved in addition to possible logistical support problems. Using the computer at UCLA involved using research funds that could only provide for approximately fifteen runs on the computer with very limited storage and time allocations.

The general approach of the study progressed consecutively through the following steps:

1. Became familiar with NWS, Concord operation and its facilities.
2. Gathered raw data from the activity.
3. Drafted a rough TRANSIM model to represent the NWS, Concord operation.

4. Organized the raw data and transformed it into usable parameters.

5. Tested the TRANSIM model on the computer for accuracy, realism, and computer efficiency, and subsequently reworked the model and parameters until the original situation was replicated.

6. Varied the parameters to determine limits of NWS, Concord capability.

III. INTENT OF THE PROJECT

The objective of the thesis was to create a simulation model that could predict the maximum export capability of the NWS, Concord. One way to hypothesize the ultimate capability of an activity was to find the historical maximum output of the activity and let that be the maximum capability. This analysis used the historical maximum output of 387,113 long tons in the first half of 1968 (Vietnam War period) as a basis for a simulation model, emphasizing high productive factors and de-emphasizing low productive factors in the activity, to predict greater capability. The system considered for analysis is defined, restrictions and assumptions stated, and then the analysis proceeds. As the study progressed some of the system boundaries and assumptions were changed or modified and are noted.

The Concord facility loads ammunition for many ports in the Pacific Ocean area, often on the same vessel. Of course, stowage of the cargo aboard a vessel requires ordering of the cargo being loaded to insure direct access by the unloading ports. This model has not provided specifically for such ordering of cargo, having thought that this function more properly belongs in the planning phases of transportation and not the operational loading phase. The longshoremen load what is sent to them and it is this aspect of the Concord export mission that is examined.

The research indicated that often many records of data were not available. The intent of the analysis was to take the best available data, both official and unofficial, and,

if appropriate, apply it to the model. Most of the 1968 data was kept at Concord for historical reasons only. Not all divisions in the Concord facility require or desire such information. Consequently some data was from 1968, while other data was from 1976 and 1977, and still other data has never been gathered.

The TRANSIM program has a capability to analyze a system in extensive detail. In the instance of a marine port complex, to model movements of pallets, forklifts, dunnage, railcars and many other small but identifiable units is conceivable, but the expense is great and the time involved is in terms of months and years. This simulation of NWS, Concord was an attempt to model the most significant elements in the determination of export tonnage moved. Every effort was extended to keep the model as real as possible. As the study progressed many decisions regarding the system boundaries and data elements centered on the issue of realism versus model scope and efficiency. To keep the scope and efficiency manageable, assumptions and approximations were necessary, but they were always juxtaposed against the desire for realism to insure the most reasonable product.

This paper progresses by defining the operational process at NWS, Concord, then defining the TRANSIM model in its final forms, followed with a derivation of the specific data. Finally the results are discussed and some conclusions offered.

IV. ASSUMPTIONS

To build the model, assumptions had to be made. First there were broad, general assumptions which held for the entire model and all systems considered. Second, there were specific assumptions which were directly applicable to a portion of the system, an element of data, or a decision rule in the model. However, specific assumptions were not necessarily void of any influence on any other system element or model decision rule. They could indirectly effect another element or rule and could thereby influence results in more than one way. The specific assumptions are listed in Chapter Six while the general assumptions are as follows:

1. An adequate labor force was available to maintain maximum strength of all possible working elements in the port simultaneously.

2. All necessary equipment and maintenance facilities were available to provide sufficient cargo handling capabilities for all possible working elements in the port simultaneously with a nominal deadline rate allowed. The nominal deadline rate was presumed to be whatever was acceptable by the activity during 1968 operations.

3. Sufficient administrative and logistic support was available to supply the needs of operational forces.

4. No container operations were allowed except for the occasional deck stowed container which must be loaded with ship's gear.

5. The year 1968 was representative of a balanced system at NWS, Concord while handling a record amount of ammunition. A balanced system was defined as one where the

inputs equaled outputs, that is, no cargo was created or destroyed within the system.

V. THE NAVAL WEAPONS STATION, CONCORD TIDAL AREA

Before NWS, Concord can begin the planning for and the processing of export cargo, higher authorities outside the facility coordinate land movements of cargo to meet vessels in various ports. From these authorities, notices of vessel arrivals, cargo loads, and destinations are received as well as information on cargo arrival by highway and rail. Upon receipt of this information, NWS, Concord begins planning for the positioning of the cargo in the storage areas and for the handling of the cargo to provide orderly and safe stowage of the cargo aboard the vessel.

A. PLANNING CONSIDERATIONS

The positioning of the vans is essentially void of any restrictions since the parking area is centrally located with respect to the berths and except for the occasional trailer-load of dynamite, the van requires no bunkers or other protection. On the other hand, the positioning of railcars considers the separation of dynamite into specific bunkers and the storage location with reference to the expected vessel's berth. Specific bunkers are assigned for dynamite only, as the need arises. The inflexibility of the routing of railcars due to the layout of the track in the storage area demands extensive planning for the railcar storage location. Therefore, proper positioning of the railcars can prove more efficient when the berth is accessible directly from its storage location instead of indirectly through numerous switches. Although a railcar

can be moved to any berth from any storage location, some of the track is directly accessible to only two or four of the berths.

Vessel berth assignments are dependent upon projected available berths and upon cargo storage location since all the berths have essentially the same physical characteristics. Even though planning is done, the berth assignment is often changed due to a change in priorities or delays of cargo or vessels. These changes can cause previously developed plans to be discarded and inefficient situations to arise.

B. VAN AND RAILCAR MOVEMENT PROCEDURES

When a truck arrives with cargo it is inspected, received (a paperwork accounting process), and sent to a specific numbered location in the storage area. Often the prime highway mover transfers the trailer to a U. S. Navy owned and operated tractor at the receiving point, so that the trailer is parked in the storage area by NWS, Concord personnel. At other times local drayage firms, familiar with NWS, Concord procedures and facilities, are allowed to park the trailer. Once parked, the trailer remains stationary, without tractor, until called for loading aboard a vessel. (Since most trailers are vans as opposed to flatbeds, van and trailer will be used interchangeably throughout this paper. Tractor will refer to the prime mover, and truck will indicate a combination of tractor and van or trailer.)

When a train arrives, NWS, Concord railroad personnel are advised, and arrange for the inspection and receiving of the railcars. Then the yardmaster directs switching

operations to segregate the cars into specific numbered bunkers in accordance with the aforementioned plans where they remain in storage until called for a vessel.

When notification of vessel arrival is obtained, operations personnel mobilize the labor and equipment to accomplish the planned loading of the vessel. As specific cargo is required for loading, notification is provided through a central locator to either the railroad or tractor operators to move a particular railcar or trailer from its storage location to a specific location on a designated berth. Once the conveyances have been unloaded, the railroad and tractor operators are again notified of the movement requirements. Later, notification is given to the owner of the trailer or railcar that it has been unloaded and is available again for his use. Once the vessel is loaded with its intended cargo, the vessel is secured, and provided with sailing instructions.

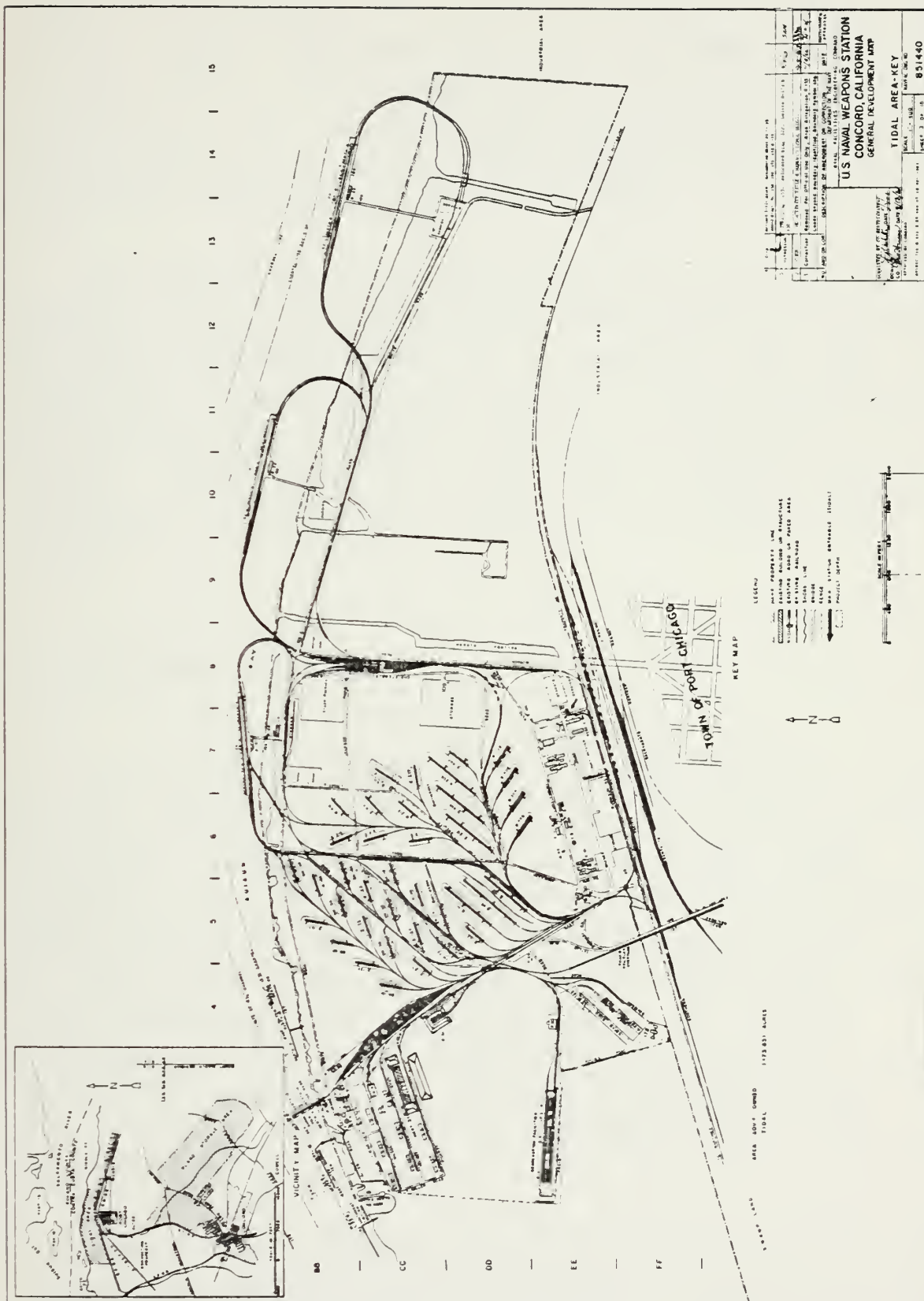
C. AREA CAPABILITIES

The following physical characteristics and operational limitations of the NWS, Concord facility are noted. The Tidal Area has three quays with two berths each for a total of six berths. It is possible to simultaneously have a C-5 type vessel at each berth while retaining an ability to work all hatches from the quay side of the vessel. Each quay has at least two parallel tracks entering and one track exiting the berth areas expanding to four parallel tracks in the actual vessel berthing area. For safety, no more than twenty-five loaded railcars are allowed on a quay at any one time, with no more than fifteen loaded railcars allowed at a berth at one time.

There are 38 bunkers with a total capacity of 244 railcars. The bunkers are in three sizes, capable of storing either four, eight, or twelve fifty-foot railcars. This number of variously sized bunkers allows many storage configurations, providing compatibility for all classes of ammunition. The distinctions in ammunition compatibility which could effect the rail storage capacity are minimal due to the number of bunkers and their varying size. In addition to the bunkers, there are two classification yards that can be used for storage of 287 railcars providing that the safety requirements, such as the area net explosive weight limitation and ammunition compatibility requirements, are met. Therefore the actual railcar capacity is approximately 531.

The van storage areas consist of two paved and marked parking lots with an approximate total capacity of 200 vans. The ability to store a surge of vans, possibly 150 more, for a short period of time is possible when consideration is given to using unpaved and unmarked open areas and even roadway shoulders. The only limitations for continued efficient operations are localized congestion in a storage area and the distance of the storage area from the berths. Additionally, van cargo is sometimes transferred to U. S. Navy owned railcars on station. This provides an added flexibility if the van storage becomes congested. This analysis considered the van storage capacity at 200 trailers.

In the instances just mentioned, the implication is not that NWS, Concord can store an unlimited number of railcars or trailers. However, it must be emphasized that the stated restrictions on the storage capabilities are not the strict limitations for the entire facility. In fact, in addition to the areas mentioned above, there are additional storage areas in the Inland Area. These other storage areas have



been used in the past, specifically in 1968. It is important to realize that once the normal railcar and trailer storage capacities, 531 and 200, respectively, have been achieved, in all probability the efficient movement of conveyances will decrease. This paper did not analyze how that efficiency varies but assumed maximum efficiency can be achieved at the normal capacities stated.

The station also has a barge pier and a large number of barges for use in the port area. The barges can be loaded by mobile pier-based cranes at a separate pier that is accessible to both vans and railcars. This allows cargo to be transferred to a vessel at anchor in the stream or to a berthed vessel from the water side, or simply placed in temporary storage until required for loading aboard a vessel.

D. OPERATING TIMES

Normal operating hours for the longshoremen labor force at NWS, Concord are 0800 to 1700 hours with a one-hour break for lunch. Additionally, fifteen-minute smoke breaks are provided after two hours of each four-hour work period. During periods of two shifts, the second shift is from 2000 to 0500 hours with the same breaks as the first shift. Other employees that interface with or support the longshoremen may start slightly earlier or later. During periods of two shifts, all elements are staffed except for the receiving and inspecting functions which work only eight-hour days.

At the berths, because of safety requirements, there are limitations on when switches of railcars and vans can be made and the size of the switches. Standard operating

procedures at NWS, Concord provide for switches between the hours of 1200 to 1245, 1700 to 1945, 0000 to 0045, and 0500 to 0745 when no cargo operations on the vessels occur. Switches can also be made during the fifteen-minute smoke breaks. Also, safety restrictions limit the number of cars in a single switch anywhere in the Tidal Area to twenty-two railcars.

Additionally, it is mandatory that all vans on the berth be removed from the track area at the berth prior to any movement of railcars, and only after the railcar movement is complete at the berth may vans be placed back in position at the berth for unloading. This procedure must be followed because for unloading, the vans are placed across the railroad tracks and thereby restrict railcar movements.

Nominal time for the movement of trains is forty-five minutes in the berth area. This allows only for the positioning of the cars at the berth and does not include time for retrieving the desired cars from their various storage locations. The retrieval time will depend on the number of cars involved, their relative location, and their grouping. The nominal time for a van movement is twenty to thirty minutes one-way. This provides time for locating the van, connecting it to the tractor, raising the dolly, positioning the van, lowering the dolly, and disconnecting the van.

VI. THE TRANSIM VIEW OF NWS, CONCORD

This chapter portrays the system just described from the view of the simulator. The modifications of the system and the specific assumptions are specified.

A. SYSTEM BCUNDARIES

Originally the boundaries coincided with the geographical perimeter of the NWS, Concord Tidal Area. This allowed three openings in the perimeter for the entry and exit of cargo. Cargo entered the system by rail and truck and left aboard vessels. The empty vessels originated at the system boundary at the quays and after loading at the berths departed the system. However, provision had to be made for anchorage of vessels awaiting an empty berth. Therefore, the system boundary was extended to include a harbor of sufficient size in which to anchor all the vessels that might require waiting.

Also it was intended that the trains and trucks would enter at the boundary gate, the physical device the conveyances actually passed through to enter the Tidal Area. Due to the lack of data and in consideration of the simulation objective, the function was deemed irrelevant. The primary elements in the determination of export capability were the number of vessels, the tonnage loaded, and the capability of the storage areas to accumulate sufficient cargo to keep the vessels supplied with the required cargo while not exceeding the normal storage

capacity. As a result the system boundaries were drawn in to the truck and railcar storage areas.

After the railcars and trucks were unloaded at the berths, they left the system. It was assumed that there existed enough storage space for empty conveyances both within the perimeter of the Tidal Area and on adjacent roads and tracks and/or that the local carriers would pickup their empty trailers and railcars so that the storage of empties would not impact on the tonnage exported.

B. BASIC ELEMENTS OF THE MODEL

The TRANSIM program accounts for the location and activity of traffic units. Traffic units are the smallest identifiable elements in the system. In this model, the traffic units originally were long tons, vans, railcars, and vessels. The greatest problem in the exercise was the organization of the raw data into a form that would provide efficient use of the TRANSIM model within the time and funding constraints dictated. The first computer run providing detail in terms of tonnage (long tons) used an inordinate amount of computer capability, and required reconsideration of the validity of the four traffic units.

Dropping long tons from the primary elements was the first modification of the original plan and resulted in subsequent data approximations and assumptions. The smallest traffic units became the conveyances themselves, specifically the trucks, the vessels, and the railcars. It seemed reasonable to assume an average cargo load per conveyance from which gross tonnages could easily be calculated when needed.

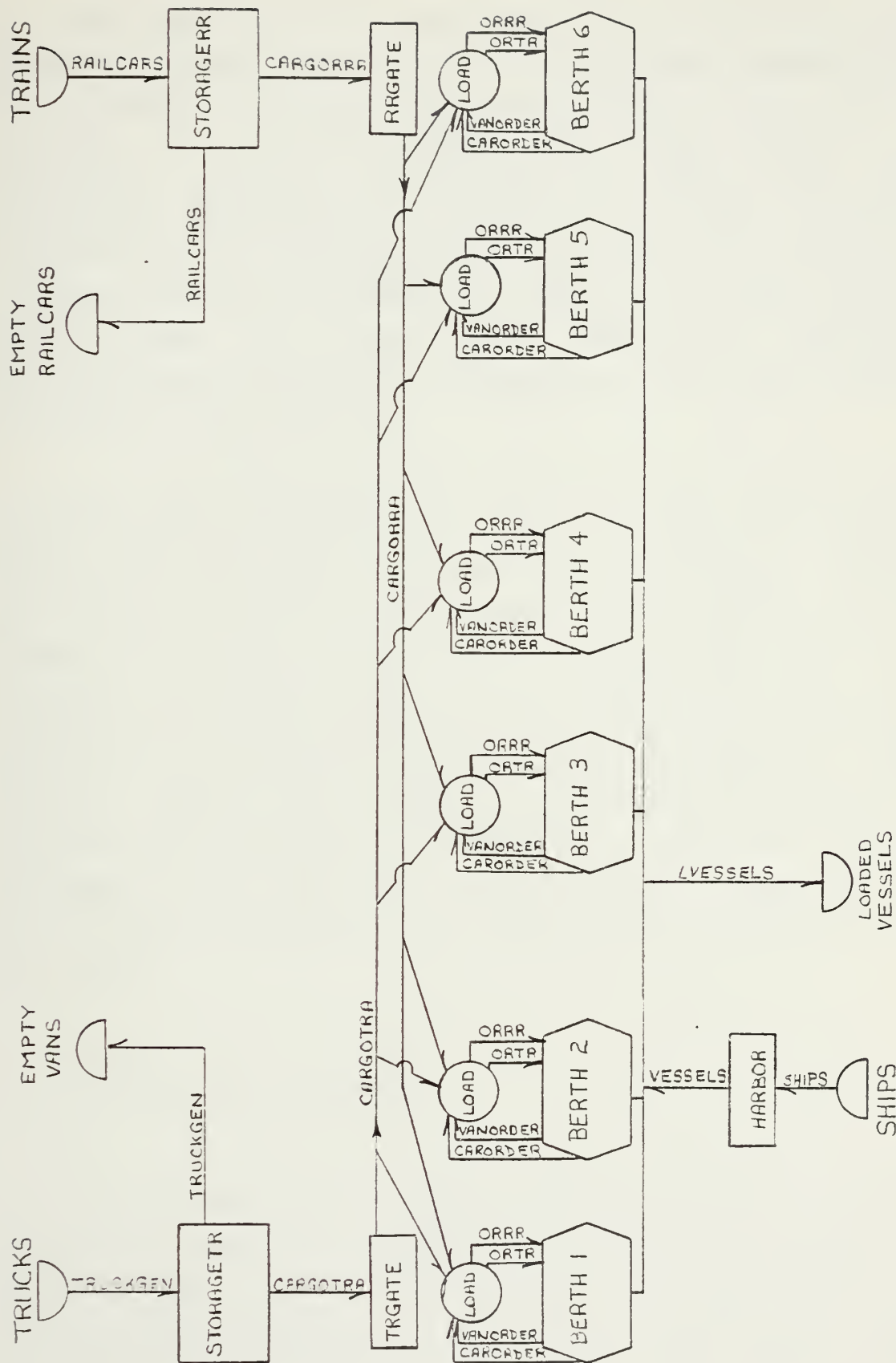


Figure 3 - DETAILED SCHEMATIC

Even though each van and each railcar had the same average tonnage as any other van and railcar, respectively, it was essential for the model to identify each van and railcar to determine times each element spent at a particular activity. Throughout the model, vans were identified individually. However, for trains a further consolidation was deemed necessary after the early test runs continued to show an inordinate demand on computer time and memory while the model was maintaining individual accountability of railcars. Therefore, trains were composed of groups of ten railcars.

This one consolidation caused the most concern in the entire model development. It meant the complete sacrifice of any attempt to model the switching restrictions (22 cars per switch) or berth railcar capacities (25 railcars per two vessels with no more than 15 railcars per vessel) and/or the allowable switching times. To achieve both the most efficient computer use and desired realism was not possible. Efficient computer use required grouping the railcar units. Realism required that railcars be individually identified to facilitate the movement of railcars in both the amounts specified and at only the allowed switching times. Realism had to yield to efficient (in terms of cost) computer use in the model.

C. ALTERNATIVE APPROACHES

The objective of the project was achievable in two ways. The model could be structured to generate cargo from the storage areas at a prescribed rate and load the vessels to a predetermined capacity at which time they would sail. Then a comparison of simulated berth times with actual berth

times would render possible conclusions. Alternatively, the vessels could be called in berth for a prescribed time to load a predetermined amount of cargo. Then comparisons could be made between the simulated accumulation of cargo in the storage area with the physical ability of the storage areas to efficiently handle the cargo. The latter approach was chosen for the following reasons:

1. Berth time data was available while cargo arrival, storage, and handling times could only be guessed, because historical data was not available and current data was insufficient.

2. The second alternative seems more realistic in that plans are usually made first for the vessel's cargo while the handling and storage capabilities of the port are secondary conditions, if considered at all.

Using total berth time as a driving force allowed the model to be less detailed than the switching time restrictions, switching size limitations, and the berth railcar capacity limitation required. The ten-railcar traffic unit appeared to be a plausible approximation. Two of the consolidated units were 91 percent of maximum switch size. If only one vessel was at a quay, a consolidated unit was 67 percent of the berth railcar capacity, and if two vessels were in adjacent berths, a more likely situation when trying to maximize tonnage output, two units were eighty percent of capacity. If one consolidated unit of ten railcars was associated with a vessel, none of the safety restrictions would be violated and, assuming that a requirement for all switches and berth railcar storage capacities to be maximized all the time is not realistic, the number of railcars available for unloading on the berths was tolerable.

Regarding the only other variable, switching time restrictions, the allowance for the switching time had to be realized in a reduction of the unloading rate. Implicit in this arrangement was the assumption that the units of ten railcars was neither too large nor too small to have a significant effect on the tonnage loaded, and that in the long run the cargo loaded during switching times would balance the lack of cargo during cargo loading times.

D. DATA ELEMENTS

Raw data was obtainable either from records or interviews for most elements within the Tidal Area. The data base consisted of either capacity elements or time elements. Capacity elements included vessel loading space, van and train storage capacities, and tonnages on vans, railcars, and vessels. Time elements were vessel loading and vessel total berth times, interarrival times of trucks, trains and vessels, inspection and receiving times of vans and railcars, movement times of vans and railcars both from receiving to storage and from storage to berths for unloading, and unloading times of vans and railcars.

1. Capacity Elements

Storage and berthing capabilities were taken from existing facilities in April 1977. These were the same as in 1963, except for the first forty-five days of 1968, when two of the berths were still under construction. (All 1968 data in the model has been prorated to provide an equivalent full year's capability.) In the past, vessels at NWS, Concord have occasionally loaded cargo, usually in very small tonnages, while at anchor in the stream and have

loaded vessels from the harbor side of a vessel while at a berth. The stream operation was not considered in the model but the barge operation on a berthed vessel, while not specifically modeled is allowed in the way the model evolved. Therefore six vessels, one per berth, were considered loadable at any one time.

The model assumed a nominal storage capacity of 530 railcars and that safe storage could be provided all types of ammunition. For the model the van storage capacity was 200. Storage of cargo on barges was not included in the model.

In 1968 NWS, Concord exported a record number of long tons of ammunition and this was thought to be the most appropriate year in which to base the model to determine the port's ultimate capability. The official manifest tonnages of 1968 vessels were available and were used in the model. The data indicated a broad spectrum of tonnages loaded aboard vessels, from eight tons to over ten thousand tons. In order to categorize vessels, they were divided into ten classes, each class with a range of one thousand tons. This allowed for a distribution of tonnage by class and also a distribution of vessel frequency by class. For each class an average tonnage was calculated and used as the tonnage for that class of vessel.

Truck and rail tonnages were not available for 1968. This data was taken from 1976 records and averaged to obtain a nominal tonnage per conveyance. The implicit assumption is that the tonnage per conveyance would not change significantly over time.

2. Time Elements

Much of the time data was not recorded; in fact, only the total berth times of the vessels were recorded. However, from the berth time data, vessel interarrival times were calculated. Although not recorded, the working time of a vessel was the only other time data that had a possibility of validation. Records did not indicate the precise working and non-working times on a vessel. Since only a guess, based on normal working hours, could be made on vessel loading times, all vessel tonnage capacities and loading rates were based on total berth time. To determine the port capability two shifts were assumed.

Because of the adjustments of the system boundaries to the storage area, it was not necessary to represent inspection times, receiving times, or movement times of vans and railcars into their respective storage areas. The critical issue was to show an arrival of vans and railcars into a storage area where they could be available for unloading to a vessel. But no records of truck or train interarrival times were available. To model cargo arrivals, NWS, Concord employees were interviewed to obtain their "best guess." For vans, the arrival process occurred over an eight-hour span in the day shift, while the railcars were usually moved in a group at one time during the day or in groups of railcars just a few times a day.

The simulation allowed trains to arrive only at 0800 hours, precluding multiple time arrivals during the day. Since the usual practice in ports is to have cargo on hand prior to a vessel's arrival, this assumption was not unrealistic. However, to simulate the arrival of different numbers of railcars during a day the number of train arrivals was said to obey a distribution of one train arrival 50 percent of the days and either no train arrivals or two train arrivals, each 25 percent of the days. Depending on expected vessel berth occupancies, the number

of trains, with ten cars per train, could be probabilistically varied to satisfy the vessel cargo requirements. The overriding influence was to balance inputs with outputs and ensure sufficient railcars in storage to allow the system to operate in apparent realism.

Truck arrivals were simulated differently. It seemed appropriate to represent truck arrivals by a Poisson distribution. Except for a possible buildup early in the receiving period, the Poisson distribution would represent a random arrival pattern. However, the stipulation was included that trucks could be received only between 0800 and 1600 hours to simulate the real-life situation of trucks being received for only one eight hour shift. The Poisson distribution worked on a twenty-four hour basis but specific rules were included in the program to cause trucks that arrived between 1600 and 0800 hours to leave the system with no other action. The mean interarrival time was dictated by balancing the output of trucks with the input of trucks for the system. The mean interarrival time was calculated by dividing the allowed eight hour receiving period by the average number of trucks to be input daily into the system. Again, the effort was directed to ensuring sufficient arrivals in the period to match the demands of cargo by the vessels.

As a check of this hypothesized model, the timing of cargo input was considered a function of tonnage, as already inferred. To provide for cargo input, cargo coming into the system was assumed to equal the cargo coming out of the system over a long period of time. Specifically the model was structured to have the cargo entering by trucks and trains equal the cargo loaded on vessels in a six month period. With the knowledge of the tonnage exported and the tonnage per truck and train, only the arrival rates had to be determined for the trucks and trains. However, the ratio

of vans to railcars was not available. A "best guess" by some of the experienced employees at NWS, Concord was the best information available. A ratio of three railcars to every truck was determined to best represent the actual situation.

The only unresolved times were van and railcar movement times from storage to berth and the railcar and van unloading times. Again no specific records were available and the basis of the model was conversation with experienced NWS, Concord employees. The best solution was an attempt to represent the vessel berth time in terms of cargo loaded. Assuming the ratio of railcars to trucks remained the same as the receiving rate (three to one) it was possible to calculate a vessel loading rate.

The model did not count the movement time from storage to berth. In effect, this time is made a part of the loading time of the vessel. Without including the switching limitations described earlier, the movement time has no meaning in any case.

E. SYSTEM SUMMARY

In summary the model is set up with three independent variables: vessels, vans, and railcars, and several dependent variables, which cannot be statistically verified. Therefore several pilot runs of the program were made, relying on the author's judgement to recognize an improbable result and correct it. Apparent errors in the functional data relationships were found, and production runs were not made until the model was able to replicate real situations in the past. The actual operating rules of the model are defined in Appendix A.

The specific assumptions stated above are summarized as follows:

1. Local carriers pick up empty conveyances or sufficient van and railcar storage space exists such that empty vans and railcars do not impact on export tonnage.

2. Movement times of conveyances from storage to berth, and switching limitations can be incorporated into an average vessel loading time for all classes of vessels.

3. Vans and railcars consolidating pallets of cargo can properly represent tonnage loaded aboard the vessel.

4. Railcars in groups of ten can be moved as a unit throughout the system.

5. The historical relationship between vessel tonnage and berth time is valid for any time period.

6. The cargo mix of various explosive categories can be safely stored in the normal areas.

7. The randomness of the simulation's Monte Carlo technique provides mean values over a six month period.

8. Hypothesized arrival distributions and interarrival times are valid approximations of the real situation.

9. The average ratio of railcars to trucks in and out of the system is three to one.

10. Loading operations with vessels in the stream are not allowed.

11. The average van and railcar tonnages are constant over time.

VII. THE DERIVATION OF THE PARAMETERS

Numerous assumptions have been made in an effort to transform the real situation into a form acceptable for both the TRANSIM program and efficient computer utilization. It is only appropriate to be more specific in the methods used to organize the raw data into parameters. Throughout all the simulation runs the distribution of vessel classes, the vessel class berth times, the number of vans and railcars per vessel class, the unloading times of vans and railcars, and the interarrival time of trains were the parameters held constant. These constant parameters are now described, while the parameters that were changed to create different effects in the simulation are described later.

A. PARAMETERS HELD CONSTANT

1. Distribution of Vessel Classes

For each vessel that arrived and departed (made a turnaround) from January 1968 through June 1968, the raw data furnished the name of the vessel and its manifested tonnage in long tons. This data was ordered and plotted in histogram fashion (Appendix J) with ten equal intervals of tonnage (the intervals were all equal to 1000 tons except the interval at the highest range of tonnage which was allowed to include all greater tonnages) plotted against the number of vessels. The number of tonnage intervals and the interval length itself were arbitrarily designated. The

lowest tonnage interval (0 to 1000 long tons) was assigned class 1, and the classes progressed consecutively higher to class 10 (9000 long tons and above). By dividing the number of ships in each class by the total number of ships (76), a distribution of vessels by tonnage class was achieved (Figure 4). In the TRANSIM program this distribution was called the "shiprule."

One qualification of the raw data stated above must be clarified. Recall that the only data used was for ships that completed a turnaround within the six month period. This eliminated any vessels on berth at the beginning of the period and also those that failed to complete operations by the end of the period. Remember also that AEs are not included and that vessels involving any discharge operation are not included.

VESSEL CLASS	PERCENT OF VESSELS
01	6.6
02	2.6
03	2.6
04	7.9
05	18.4
06	30.3
07	21.1
08	7.9
09	1.3
10	1.3

Figure 4 - VESSEL CLASS DISTRIBUTION

2. Vessel Class Berth Times

The same raw data above also contained the vessel's arrival and departure times from its berth. From that data total berth times, to the nearest quarter hour, were calculated for each ship and plotted against the vessel class in which that ship belonged. Within the vessel classes, there appeared no correlation between vessel berth time and tonnage loaded. However, there was a trend of increasing berth time with corresponding increase of vessel class, which was expected.

The berth times in each vessel class were simply averaged to obtain a mean. To give the same randomness to the simulation that the raw data for each class did reflect, a ten percent spread on either side of the mean was arbitrarily assigned to a triangular distribution (Appendix K). (The triangular distribution is a device incorporated in TRANSIM that assigns probabilities). The variance was strictly arbitrary and was adjusted for the large class vessels, after test runs indicated invalid results in which the higher class vessels were not able to achieve their prescribed tonnage in the allotted time. Therefore, vessel classes eight, nine, and ten had increased variances to rectify this problem (see page 48 for discussion of loading times). Figure 5 gives the distribution of berth times for the various vessel classes.

VESSEL CLASS

TIME ON BERTH

	LEAST	AVERAGE	MOST
01	103	114.3	125
02	137	152.6	167
03	165	183.4	201
04	170	189.2	203
05	184	204.1	224
06	186	206.1	226
07	190	211.4	232
08	192	213.9	240
09	198	220.0	230
10	221	245.5	340

Figure 5 - BERTH TIMES BY VESSEL CLASS

3. Vans and Railcars per Vessel Class

It was desirable to make the tonnage for each class of vessel an even multiple of the railcar tonnage to avoid the necessity of accounting for partial loads in vans and railcars, which would be another burden upon computer storage and a complicating element in the model. Therefore the vessel tonnages, although based on the average tonnage, were approximations.

To determine the tonnage unit required, the average tonnages per van and railcar were found. The only reasonable record of van and railcar tonnages was from 1976. It is logical to expect the average tonnage of vans and railcars to be relatively constant over time. The one possible cause for variance might be the nature of ammunition required due to a particular type of conflict (napalm bombs are much lighter than explosive bombs).

Van and railcar tonnages were based on data generated in the first six months of 1976. The average long tons per van and the average long tons per railcar were calculated to be 15.9 and 53.2 respectively. After many trials at what might have been even multiple combinations that seemed reasonable, 18 long tons was chosen as the average weight of a van with 54 long tons the average weight of a railcar. Consequently each average vessel tonnage was rounded to the nearest multiple of 54 long tons.

Although these tonnages were included in the computer input data, they were not actually used in the simulation due to the elimination of the long ton traffic unit. Figure 6 shows the actual average long tons per vessel class and the average used in the simulation.

VESSEL CLASS	LONG TONS	
	SIMULATED	ACTUAL
01	540	540
02	1674	1670
03	2160	2154
04	3726	3738
05	4536	4551
06	5400	5409
07	6480	6462
08	7398	7422
09	8154	8163
10	10152	10132

Figure 6 - ACTUAL VS. SIMULATED TONS PER VESSEL CLASS

The number of railcars and vans per vessel class was an easy calculation once the ratio of railcars to vans was established. Applying the 3:1 ratio assumed above, the solution of two simultaneous equations provided the number of vans and railcars. The equations were:

$$1.) \text{ CARGO TONNAGE ABOARD VESSEL} =$$

$$\begin{aligned} & (\text{NUMBER OF VANS}) (18 \text{ LONG TONS PER VAN}) + \\ & (\text{NUMBER OF RAILCARS}) (54 \text{ LONG TONS PER RAILCAR}) \end{aligned}$$

$$2.) \text{ NUMBER OF RAILCARS} = 3 (\text{NUMBER OF VANS})$$

The general feeling of personnel at NWS, Concord was that the tonnage received in railcars in relation to the same for trucks had decreased in the past few years. Without data this was impossible to verify and it is only hoped that the data, if available, would prove relatively consistent with what has been hypothesized. When it became apparent that the grouping of railcars into units of ten was a more efficient way to model the system, the result was a necessary rounding of the number of railcars, or trains, per vessel to the nearest multiple of ten and consequently an effect on the van/railcar ratio to achieve the desired tonnage per vessel class. The results of this consideration is summarized in figure 7.

VESSEL CLASS	VANS		RAILCARS	
	ACTUAL	THEORETICAL	ACTUAL	THEORETICAL
01	3	3	10	9
02	3	9	30	28
03	0	9	40	37
04	27	18	60	63
05	12	27	80	75
06	30	30	90	90
07	30	36	110	108
08	51	42	120	123
09	33	45	140	136
10	54	57	170	169

Figure 7 - ACTUAL AND THEORETICAL NUMBERS OF VANS AND
RAILCARS PER VESSEL CLASS

Consideration was given to making the distribution of railcars and vans per vessel random, but was not implemented for three reasons. First there would be no assurance that the length of time or number of vessels generated in the simulation would be sufficient to cause the average tonnage in a vessel class to achieve its desired level. Secondly, the vessel berth time was an independent and overriding factor on tonnage loaded, that is, even though the simulation may have generated a higher than average number of railcars and vans for a vessel, there was no way they could be loaded on the designated vessel once its berth time had elapsed. Finally, the distribution would have been a guess, and that would only compound the uncertainty already incorporated in this part of the model. This determination of traffic units per vessel was necessarily uncertain and, regrettably, the detail which was initially desired sacrificed.

4. Unloading Times of Vans and Railcars

As previously discussed, the actual time of loading the cargo from vans and railcars onto the vessel was not documented in records at NWS, Concord. In any instance, this would have been difficult to correlate with the total berth time of the vessel which also included significant amounts of non-productive time. Therefore by trial and error, considering the number of traffic units necessary to achieve a desired vessel tonnage class, the ratio of trucks and vans unloaded, and the berth time of the vessel, unloading rates were obtained. The nominal times used were ninety minutes for a van and two hours for a railcar. To an experienced port operator these times may seem high. But recall that this rate of unloading considers not only the sixteen hours of available productive time in a twenty-four

hour period but also, shift changes and breaks, meal times, vessel rigging times, cargo compartment opening and closing times, blocking and bracing times, vessel time between docking and commencement of operations and time between ceasing of operations and sailing time, cargo delays, equipment breakdowns, and short hatches. The figures seem more plausible when the average tons loaded on a vessel per hour of berth time for the January 1968 through June 1968 period was 25.8 long tons. In the pilot runs of the simulation these times were analyzed very closely to insure that the cargo was loaded within reasonable times of the vessel departure. The times were adjusted somewhat, along with vessel berth times (see page 41) to insure the simulation was as realistic as possible.

Dependent upon the type of cargo in the vans or railcars the unloading rate could vary. Based on interviews with operating personnel at NWS, Concord a spread on either side of the mean loading times of 45 percent for vans and 30 percent for railcars was assigned. In the pilot runs this randomness was monitored and provided reasonable realism to the simulation.

5. Interarrival Time for Trains

The basic idea for rail arrivals was to have an average of one train a day arrive and to vary the number of railcars in the train to make the number of railcars variable. However, it was a simple task to also vary the number of trains per day and achieve more realism. Therefore, still basing the train input on a mean interarrival time of one per day, the number of trains was allowed to vary from 0 through 2 per day on a stepwise uniform distribution.

B. PARAMETERS TO BE VARIED IN SIMULATIONS

The variable elements of data include the interarrival time of vessels, the interarrival times of trucks, and the number of railcars per train.

1. Interarrival Time of Vessels

The average interval between ship arrivals was calculated from the number of vessels in the six months compared with the total time in hours. The original result, based on seventy-six vessels, was a mean interarrival time of fifty-seven hours. The distribution of arrivals was specified as Poisson. The Poisson distribution was used throughout the simulation runs but the mean interarrival time was changed depending on the number of vessels desired for berthing in each run.

With the available berth time for six berths over 180 days equal to 25,920 hours, and the historical data base giving an average of 197.5 hours berth time per vessel, the equations used to calculate the mean interarrival time were:

1.) NUMBER OF VESSELS =

$$\frac{\text{TOTAL BERTH OCCUPANCY TIME}}{\text{AVERAGE BERTH TIME PER VESSEL}} =$$

$$\frac{(\text{OCCUPANCY RATE}) (\text{AVAILABLE BERTH TIME})}{\text{AVERAGE BERTH TIME PER VESSEL}} =$$

$$\frac{(\text{OCCUPANCY RATE}) (25920 \text{ HOURS})}{197.5 \text{ HOURS PER VESSEL}}$$

2.) INTERARRIVAL TIME =

$$\frac{\text{TOTAL TIME}}{\text{NUMBER OF VESSELS}}$$

2. Interarrival Times for Trucks

The distribution for truck arrivals was also assumed to be Poisson. For the original runs the mean interarrival time was forty-five minutes. With this distribution the number of trucks entering, leaving, and stored in the storage area seemed reasonable in the test runs. However, when greater tonnage requirements existed due to increased berth occupancy it was noted that the relationship between truck arrivals and vessel classes on berth was extremely critical. When vessels that required great numbers of vans were in a berth, there were insufficient numbers of vans in storage to satisfy the demand. Therefore, in later runs, the mean arrival rate was arbitrarily increased and decreased depending on the supply of trucks, resulting in a non-homogeneous Poisson distribution. This gave added realism to the model because the nature of truck transportation and truck detention rates are such that trucks are used when the interface time with another mode is imminent or short. To calculate the mean time when the vessel loading requirements were varied, the following equations, with the historical data base giving an average of 25.197 vans per vessel (assuming the 3:1 railcar:van ratio, adjusted only for rounding due to the grouping of railcars), were used:

1.) NUMBER OF VANS PER DAY =

$$\frac{(25.197 \text{ VANS PER VESSEL}) (\text{NUMBER OF VESSELS})}{\text{NUMBER OF DAYS PER PERIOD}}$$

$$2.) \text{ VAN INTERARRIVAL TIME} = \frac{(8 \text{ RECEIVING HOURS PER DAY})}{\text{NUMBER OF VANS PER DAY}}$$

3. Number of Railcars per Train

The number of railcars per train was a direct result of balancing inputs with outputs. The average number of trains (ten railcars per train) per vessel was 8.593, from the historical data base (assuming again the 3:1 railcar:van ratio, adjusted only for rounding due to the grouping of railcars). The following equation provided the number of trains required:

$$\text{NUMBER OF TRAINS} = \frac{(8.593 \text{ TRAINS PER VESSEL}) (\text{NUMBER OF VESSELS})}{\text{NUMBER OF DAYS PER PERIOD}}$$

If the result contained a fraction, for example 5.4, then cars per train was given a distribution of 60 percent of the trains with five groups of ten railcars and 40 percent of the trains with six groups of ten railcars which provided a mean of 5.4 groups of ten railcars per train.

VIII. RESULTS

Five simulation runs of 180 day periods were made. The first three runs, I, II, and III, were made in order to replicate the original situation. Simulation runs IV and V were made with the parameters varied to attempt to find the upper limit of NWS, Concord's capability. The results of the study are included as Appendices E through I and are summarized in Figures 8 and 9.

Simulation runs I, II, and III were the runs that attempted to validate the model's accuracy, comparing percent of berth occupancy, total export tonnage, and number of ships of the historical data with the simulation results. The historical data indicated a total of 76 ships exported approximately 387,000 long tons with a 62.5 percent berth occupancy for the first six months of 1968. Although there was a small variance in the three runs' results they bracketed the original historical data very satisfactorily. Simulation run II was almost identical with the historical data.

The remaining data generated in the simulation could not be validated historically but could be compared with actual facilities in an attempt to judge the result's plausibility. Particular attention was given the vans and railcars in storage. Simulation run I generated a seemingly high number of vans and railcars in storage. To a degree, this was to be expected in comparison with simulation runs II and III in that the cargo was arriving at the same rate but fewer ships were loaded.

However, further detailed analysis indicated an adjustment in the van arrival rate might be necessary because the number of vans was steadily increasing. Therefore, simulation runs II through V had variable van arrival rates applied to the model to reflect fewer arrivals when vans in storage approached capacity and more arrivals when vans in storage were low. Henceforth, on the average, the storage requirements were consistently within the van storage capacity with the normal capacity being exceeded only in one run by 26 vans which was felt to be tolerable.

Railcars in storage did not indicate any specific necessary adjustments, but proved somewhat inconsistent. The inconsistency was noticeable in the trends of berth occupancy, tonnage exported, and the number of vessels, none of which had any correlation with the numbers of railcars in storage. For simulation runs I and V there are significant differences from runs II, III, and IV in the average number of railcars in storage.

There was another trend that had to be considered in the seeking of a maximum export tonnage. The percentage of ships turned around without any delays waiting for berth generally decreased as the berth occupancy and tonnage increased. This appeared to be logical in that unless vessels were following an extremely precise schedule, there would undoubtedly be delay times somewhere in their voyage. Every time a vessel is delayed, that vessel is not producing revenue or moving any cargo for the charter price of the vessel. An idle vessel can be extremely costly. The results indicated that high berth occupancy, although having produced large tonnages, also produced more vessel delays.

The results indicated that the greatest export tonnage in a 180 day period is about 610,000 long tons. This required 127 vessels of the assumed distribution with 99.8

percent berth occupancy. However, this operation could be extremely costly due to the number of vessels in a queue awaiting a berth. Such a high berth occupancy rate is not a very probable operation because too small an allowance is provided for vessel switching times and other delays that are bound to occur in the real situation. It was notable that such a high berth occupancy put demands on the storage facilities that were felt to be tolerable.

A more reasonable export tonnage mark to be sought is about 500,000 long tons which required 97 vessels of the assumed distribution with 77.5 percent berth occupancy. The only unfavorable factor appears to be the ship delays. The cost of ship delays may be significant, possibly somewhere between the cost of the historical operation in 1968 and the hypothetical 610,000 export tons operation. However, a 77.5 percent berth occupancy allows for the possible discharge of vessels, the handling of AEs, and/or the vacant time that would probably occur.

An element of concern could be expected when analyzing storage requirements for such a tonnage exported. Again, the data was not conclusive, but consideration had to be given requirements posed by this simulation that showed the normal railcar storage capacity would be seriously deficient, requiring 1.3 times the nominal capacity on the average and with a peak of three times the nominal capacity.

STATISTIC	SIMULATION RUN				
	I	II	III	IV	V
Berth Occupancy	52.7	60.3	69.3	99.8	77.5
Van Exports (No.)	1650	1929	2253	3132	2496
Van Exports (Tons)	29700	34722	40554	56376	44928
Rail Exports (No.)	547	597	659	1026	840
Rail Exports (Tons)	325080	322380	356860	554040	453600
Total Exports	354780	357102	397414	610416	498528
Number of Ships	69	77	90	127	97
% Ships W/O Delay	87.9	64.9	66.3	0.0	44.3
Max. Vans Stored	345	226	185	150	196
Ave. Vans Stored	177	98	55	55	94
Max. Cars Stored	1420	500	650	520	1530
Ave. Cars Stored	722	114	136	105	900
Ave. Time Van Stored	366.0	204.5	96.0	72.2	153.9
Ave. Time Car Stored	454.3	78.5	75.0	42.5	404.9

Figure 8 - COMPOSITE RESULTS

VESSEL CLASS	SIMULATION RUN				
	I	II	III	IV	V
01	8	8	6	8	5
02	1	0	4	4	1
03	2	1	0	5	4
04	7	4	8	5	12
05	10	14	18	25	16
06	23	22	25	35	22
07	14	22	20	30	27
08	4	5	8	12	9
09	0	0	1	3	1
10	0	1	0	0	0
TOTAL	69	77	90	127	97

Figure 9 - ACTUAL NUMBERS OF VESSELS IN EACH CLASS FOR
EACH SIMULATION

IX. CONCLUSIONS

This thesis has attempted to both define a simulation model for an ammunition water port, specifically NWS, Concord, and to utilize that model to determine a potential capability of the port. The analysis has been limited in scope but is useful in modeling a port in general terms. Two conclusions can be drawn from the analysis. First, NWS, Concord can export a significant increase in tonnage, up to approximately 610,000 long tons, and second, the impact on the storage areas is not conclusive.

To increase the actual export tonnage loaded aboard vessels is a distinct possibility but it has some very definite costs. Such an operation excludes any discharge operations and precludes the servicing of any AEs. In 1968, AE's occupied a berth at NWS, Concord 7.5 percent of the time, while vessels involved in discharge were present 11 percent of the time. If it is possible to perform the responsibilities incurred with these vessels at another port, the increased tonnage provided by merchant marine cargo type vessels instead, could be significant. However, to insure sufficient vessels are on hand to receive the increased tonnage, would necessitate a great increase in the vessel delay times awaiting berth. A cost-benefit analysis would be appropriate to determine the break even point between the increased capability and the increased cost from non-productive vessels. An indication of the trend of delay times and tonnage capabilities can be obtained by comparing simulation runs II, IV, and V.

The increased tonnage just mentioned is a realization of

the capability provided by the number of vessels, berth space, and vessel loading rates. However, to conclude anything about the ability of the storage areas to handle such amounts of tonnage is not so easy. It is difficult to determine with the results herein what might happen in the storage areas. There are no definitive trends that would indicate whether the storage areas are sufficient under the conditions analyzed.

The extreme variances in the results do indicate that the vessel class mix, the sequence of vessel class arrivals, and even the railcar/van ratio loaded aboard a vessel are extremely important. That the model could not be detailed in this area may be the reason for the indecisive results. The assumptions made regarding the distribution of vans and railcars aboard a vessel have a direct effect on the drawdown or buildup of conveyances in the storage area.

Any conclusions about the storage area need to have more runs made and possibly a better data base regarding cargo types loaded aboard a vessel and the frequency of such cargo types.

It is worthwhile to have the model developed as it does at least provide a vehicle to analyze an ammunition port with a rather standard operation. The model can be used for comparative analysis between ports and, with more replications, may provide more conclusive results. TRANSIM is a tool that has proven relatively easy to use, at least in this rather general view, and is worthy of more use in this area.

X. RECOMMENDATIONS

Further study of this port could prove both interesting and worthwhile. Future analysis of the same system might explore a number of areas.

To increase the number of runs, if funds were available, for a broader statistical base would be of considerable value. Different seeds to the random number generator could be used and the variable parameters could be changed to generate possibly different and/or more conclusive results.

Although it would require a greater expense, the system could be redefined to include some of the more detailed operations or those that had to be excluded. This might provide more realism in that some of the assumptions could be deleted. Such detail, however, would require a broader raw data base on which to base the new operations.

Obviously one area that can be studied is the relationship of the storage requirements with cargo input and vessel loading. It is suggested that this might be a reasonable study, with limited funds, that involves primarily an analysis of the constant parameters. A number of runs changing these data elements might prove most illuminating.

APPENDIX A

OPERATING RULES OF THE MODEL

The operating rules of the model are defined in the order cargo might flow through the system. Some duplication is necessary to provide for the movement of cargo by the two modes of van and railcar. The index to the left of the discussion of each element or rule refers to the sample program in Appendix 3.

1. Trains (ten railcars each) are generated randomly by a given interarrival time distribution.

Example: 25 P 0 50 P 1 DAY 25 P 2 DAY

Interpretation: 25 percent of the days no trains will arrive; 50 percent of the days one train will arrive; 25 percent of the days two trains will arrive.

2. The multiples of ten railcars per train are generated randomly by a given distribution.

Example: NRR = 50 P 3 50 P 4

Interpretation: 50 percent of the train arrivals have 30 railcars and 50 percent of the train arrivals have 40 railcars.

3. At the storage area a train substitutes into a number of railcars.

Example: TRAIN S RULE NRR RAILCAR
RAILCAR S CARGORRA
CARGORRA R RRGATE

Interpretation: At the storage area a train substitutes into a number of railcars

just determined (by the previous two steps) which substitute into rail cargo units which are routed from the storage area to a checkpoint (RRGATE).

4. Trucks are generated randomly by a given interarrival time distribution.

Example: TABLE TARTRCK POISSON 45 MIN

Interpretation: A truck will arrive according to a Poisson distribution with mean interarrival time of 45 minutes.

5. At a checkpoint trucks will be routed dependent on the time of day.

Example: ELEMENT TRORIG

TRUCKEN S TRUCKGEN + CARGOTRA

CARGOTRA R 800 AM 0

1600 PM STORAGETR

2400 PM 0

Interpretation: At the point TRORIG, trucks will be routed to the truck storage area if between 0800 and 1600 hours on the day clock; otherwise they will leave the system.

6. At the storage area van cargo units are routed to TRGATE.

Example: ELEMENT STORAGETR

CARGOTRA R TRGATE

Interpretation: Vans enter the storage area and will flow out through a "gate" as vans of cargo (CARGOTRA).

7. Vessels are generated randomly by a given time distribution.

Example: TABLE TARVSH POISSON 57 HR

Interpretation: A vessel will arrive according to a Poisson distribution with a mean interarrival time of 57 hours.

8. The vessels that arrive enter the system as one of

ten classes with a given distribution.

Example: SHIPRULE = 6.6 P VESSEL01
 7.9 P VESSEL04
 21.1 P VESSEL07

Interpretation: 6.6 percent of vessel arrivals will be class 1; 7.9 percent of the vessel arrivals will be class 4, and 21.1 percent of vessel arrivals will be class 7.

9. The vessels of a particular class are given a random total berth time according to a given distribution.

Example: TABLE BERTH05 TRIANGLE 0 P 184 4R
 204.1 HR 224 HR

Interpretation: A vessel of class 5 will have a berth time according to a triangular distribution where zero percent of the time it will be on berth 184 hours or less, 50 percent of the time it will be on berth 204.1 hours, and zero percent of the time it will be on berth 224 hours or more.

10. The vessel is assigned a berth.

Example: ELEMENT HARBOR
 SHIP S RULE SHIPRULE
 VESSEL** R BERTH1 IF VESSEL** EVESSEL**
 AT BERTH1 EQ 0 OW
 VESSEL** R BERTH2 IF VESSEL** EVESSEL**
 AT BERTH2 EQ 0 OW
 ETC.
 VESSEL** R BERTH6 IF VESSEL** EVESSEL**
 AT BERTH6 EQ 0 OW
 WAIT

Interpretation: The arriving vessel goes to berth 1 if there is no vessel of any class at berth one; otherwise it screens berth two, three, four, etc., until it finds an empty berth. If all berths are full it waits until a berth empties and then occupies it.

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APPENDIX B

SAMPLE OPERATING RULES

This appendix contains a sample of the operating rules used by TRANSIM for the NWS, Concord model. The indexed portions of the figures are explained in Appendix A.

NWS CONCORD EXPORT CAPABILITY

LISTING OF SIMULATION INPUT DATA

1	NWS CONCORD EXPORT CAPABILITY	SIX MONTHS	17MAY77
2	22000	ALL LOG NO	ROOT 81739237
3	DEF FAULTS	2.6 P VESSEL02	2.6 P VESSEL03
4	DEF INITIALS	18.4 P VESSEL05	30.3 P VESSEL06
5	SHIPRULE =	7.9 P VESSEL07	7.9 P VESSEL08
6	21.1 P VESSEL07	1.3 P VESSEL10	1.3 P VESSEL09
7	1.3 P VESSEL10		
8	NRB = 50 P 3 50 P 4		
9	2		
10	NLTUN01 = 100 P 547		
11	NLTUN02 = 100 P 1674		
12	NLTUN03 = 100 P 2160		
13	NLTUN04 = 100 P 3726		
14	NLTUN05 = 100 P 4536		
15	NLTUN06 = 100 P 5400		
16	NLTUN07 = 100 P 6490		
17	NLTUN08 = 100 P 7398		
18	NLTUN09 = 100 P 8154		
19	NLTUN10 = 100 P 10152		
20	NVAN01 = 100 P 3		
21	NVAN02 = 100 P 3		
22	NVAN03 = 100 P 0		
23	NVAN04 = 100 P 27		
24	NVAN05 = 100 P 12		
25	NVAN06 = 100 P 30		
26	NVAN07 = 100 P 30		
27	NVAN08 = 100 P 51		
28	NVAN09 = 100 P 33		
29	NVAN10 = 100 P 54		
30	NVAN11 = 100 P 1		
31	NVAN12 = 100 P 3		
32	NVAN13 = 100 P 4		
33	NVAN14 = 100 P 6		
34	NVAN15 = 100 P 8		
35	NVAN16 = 100 P 9		
36	NVAN17 = 100 P 11		
37	NVAN18 = 100 P 12		
38	NVAN19 = 100 P 14		
39	NVAN20 = 100 P 17		
40	ELEMENT IRRIG		
41	TRUCKEN T TR15 IF CARGOTRA AT STORAGE LT 10		
42	OW TR75 IF CARGOTRA AT STORAGE GT 150		
43	CW TR45		
44	TRUCKEN S TRUCKEN + CARGOTRA		
45	CARGOTRA R 800 AM 0		
46	1600 PM STORAGE		
47	2400 PM 0		
48	ELEMENT HARBOR		
49	SHIP S RULE SHIPRULE		
50	VESEL** R		
51	VESEL** EVESSEL** AT BERTH1 EQ C		OW
52	VESEL** EVESSEL** AT BERTH2 EQ 0		OW

Figure 10 - SAMPLE OPERATING RULES INPUT

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Figure 11 - SAMPLE OPERATING RULES INPUT (CONT.)

[illegible]

Figure 12 - SAMPLE OPERATING RULES INPUT (CONT.)

UWS LUNCORD EXPORT CAPABILITY

155	VESSEL01 S	EVESEL01 + RULE NVAN01	VANORDER4 + RULE NCAR01	CARORDER4
156	VESSEL02 S	EVESEL02 + RULE NVAN02	VANORDER4 + RULE NCAR02	CARORDER4
157	VESSEL03 S	EVESEL03 + RULE NVAN03	VANORDER4 + RULE NCAR03	CARORDER4
158	VESSEL04 S	EVESEL04 + RULE NVAN04	VANORDER4 + RULE NCAR04	CARORDER4
159	VESSEL05 S	EVESEL05 + RULE NVAN05	VANORDER4 + RULE NCAR05	CARORDER4
160	VESSEL06 S	EVESEL06 + RULE NVAN06	VANORDER4 + RULE NCAR06	CARORDER4
161	VESSEL07 S	EVESEL07 + RULE NVAN07	VANORDER4 + RULE NCAR07	CARORDER4
162	VESSEL08 S	EVESEL08 + RULE NVAN08	VANORDER4 + RULE NCAR08	CARORDER4
163	VESSEL09 S	EVESEL09 + RULE NVAN09	VANORDER4 + RULE NCAR09	CARORDER4
164	VESSEL10 S	EVESEL10 + RULE NVAN10	VANORDER4 + RULE NCAR10	CARORDER4
165	VANORDER4 G	LONGTON4		
166	CARORDER4 G	LONGTON4		
167	LONGTON4 R			
168	VANORDER4 R	LOAD4 IF VANORDER4 AT BERTH4 GT 0 AND CARGOTRA AT TRGATE	GT 0	
169	AND EVESEL**	AT BERTH4 GT 0		
170	OW WAIT			
171	CARORDER4 R	LOAD4 IF CARORDER4 AT LOAD4 EQ 0		
172	AND EVESEL**	AT BERTH4 GT 0 AND CARGOTRA AT PRGATE	GT 0	
173	OW WAIT			
174	EVESEL01 I	BERTH01		
175	EVESEL02 I	BERTH02		
176	EVESEL03 I	BERTH03		
177	EVESEL04 I	BERTH04		
178	EVESEL05 I	BERTH05		
179	EVESEL06 I	BERTH06		
180	EVESEL07 I	BERTH07		
181	EVESEL08 I	BERTH08		
182	EVESEL09 I	BERTH09		
183	EVESEL10 I	BERTH10		
184	(EVESEL** + ALL ORIPA + ALL ORRRA) C	LVESSEL--		
185	LVESSEL** R 0			
186	ELEMENT			
187	BERTH5			
188	VESSEL01 S	EVESEL01 + RULE NVAN01	VANORDER5 + RULE NCAR01	CARORDER5
189	VESSEL02 S	EVESEL02 + RULE NVAN02	VANORDER5 + RULE NCAR02	CARORDER5
190	VESSEL03 S	EVESEL03 + RULE NVAN03	VANORDER5 + RULE NCAR03	CARORDER5
191	VESSEL04 S	EVESEL04 + RULE NVAN04	VANORDER5 + RULE NCAR04	CARORDER5
192	VESSEL05 S	EVESEL05 + RULE NVAN05	VANORDER5 + RULE NCAR05	CARORDER5
193	VESSEL06 S	EVESEL06 + RULE NVAN06	VANORDER5 + RULE NCAR06	CARORDER5
194	VESSEL07 S	EVESEL07 + RULE NVAN07	VANORDER5 + RULE NCAR07	CARORDER5
195	VESSEL08 S	EVESEL08 + RULE NVAN08	VANORDER5 + RULE NCAR08	CARORDER5
196	VESSEL09 S	EVESEL09 + RULE NVAN09	VANORDER5 + RULE NCAR09	CARORDER5
197	VESSEL10 S	EVESEL10 + RULE NVAN10	VANORDER5 + RULE NCAR10	CARORDER5
198	VANORDER5 G	LONGTON5		
199	CARORDER5 G	LONGTON5		
200	LONGTON5 R			
201	VANORDER5 R	LOAD5 IF VANORDER5 AT LOAD5 EQ 0		
202	AND EVESEL**	AT BERTH5 GT 0 AND CARGOTRA AT TRGATE	GT 0	
203	OW WAIT			
204	CARORDER5 R	LOAD5 IF CARORDER5 AT LOAD5 EQ 0		
205	AND EVESEL**	AT BERTH5 GT 0 AND CARGOTRA AT PRGATE	GT 0	
206	OW WAIT			

Figure 13 - SAMPLE OPERATING RULES INPUT (CONT.)

[illegible]

Figure 14 - SAMPLE OPERATING RULES INPUT (CONT.)

NWS UNCONRD EXPORT CAPABILITY

308	RAILCAR S CARGORRA	
309	CARGORRA R RRGATE	
310	ELFMENT	
311	CARGORRA R LOAD1	IF CARGORR1 AT LOAD1 GT 0 AND
312		CARGORRA AT LOAD1 EQ 0 OW
313	LOAD2	IF CARGORR2 AT LOAD2 GT 0 AND
314		CARGORRA AT LOAD2 EQ 0 OW
315	LOAD3	IF CARGORR3 AT LOAD3 GT 0 AND
316		CARGORRA AT LOAD3 EQ 0 OW
317	LOAD4	IF CARGORR4 AT LOAD4 GT 0 AND
318		CARGORRA AT LOAD4 EQ 0 OW
319	LOAD5	IF CARGORR5 AT LOAD5 GT 0 AND
320		CARGORRA AT LOAD5 EQ 0 OW
321	LOAD6	IF CARGORR6 AT LOAD6 GT 0 AND
322		CARGORRA AT LOAD6 EQ 0 OW
323		
324		
325		
326		
327		
328		
329		
330		
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332		
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345		

Figure 16 - SAMPLE OPERATING RULES INPUT (CONT.)

APPENDIX C

INITIAL SITUATION IN THE MODEL

The model was provided an initial situation in order to have some operations in progress at the start of the simulation. Figure 15 is a sample of the initial situation provided to TRANSIM. The railcar and van storage areas had 500 railcars (that is, 50 x 10) and 150 vans respectively. Each berth had an empty vessel prepared to load. The vessel classes chosen were representative of those classes most often loaded at the port.

DAY	0	HR	8	MIN	0	EL	STORAGE	ERR	TYPE	CARGO	RA	UNITS	52
DAY	0	HR	8	MIN	0	EL	STORAGE	ERR	TYPE	CARGO	TRA	UNITS	150
DAY	0	HR	8	MIN	0	EL	BERTH2		TYPE	VESSEL	03	UNITS	1
DAY	0	HR	8	MIN	0	EL	BERTH3		TYPE	VESSEL	04	UNITS	1
DAY	0	HR	8	MIN	0	EL	BERTH3		TYPE	VESSEL	06	UNITS	1
DAY	0	HR	8	MIN	0	EL	BERTH1		TYPE	VESSEL	07	UNITS	1
DAY	0	HR	8	MIN	0	EL	BERTH4		TYPE	VESSEL	08	UNITS	1
DAY	0	HR	8	MIN	0	EL	BERTH6		TYPE	VESSEL	01	UNITS	1
DAY	0	HR	8	MIN	0	EL	TRC	ORIG	TYPE	TRUCK	GEN		
DAY	0	HR	8	MIN	0	EL	HARBOR		TYPE	SHIP		0 TARVSH	
DAY	0	HR	8	MIN	0	EL	STORAGE	ERR	TYPE	TRAIN		0 TAPPAIL	

Figure 17 - INITIAL DATA IN THE MODEL

APPENDIX D

ITERATIVE PROCESS OF TRANSIM

This appendix provides a demonstration of the processes the computer followed during the simulation. The output shown has been extracted from one of the test runs used to verify the logic of the model. There were some errors in this test run and the reader, therefore, is cautioned to pay attention only to those portions described, which are accurate images of the model.

Items of interest are provided at the following event times:

- 15-14-51 A ship originates in the harbor and becomes a vessel (#60635) delayed in the harbor awaiting a berth because all berths are full.
- 15-18-11 A truck enters and immediately leaves the system because of its arrival between 1600 and 0900 hours.
- 15-18-53 A unit of railcars (#53187) completes consolidation with the current carorder (#59134). This completes the loading function of this unit at berth 4 and generates a completed order (NRRR #60625) at berth 4. At the same time the next carorder (59124) moves to the loading element element (MOVE 4) at berth 4 where it matches up with the current railcar cargo (CARGORR #63137) from the BRGATE. Also the next railcar cargo (CARGORR #60934) moves from storage to the BRGATE

awaiting the next carorder. (Author's note: in a later program "MOVE" was changed to "LOAD" to more accurately reflect the actual loading function being performed. The words have the same meaning throughout this portion of the extracted output.)

- 16- 8- 0 A train of 10 cars arrives, and becomes railcar cargo (CARGORRA) in storage.
- 16- 8-30 A truck arrives during receiving hours and becomes van cargo (CARGOTRA) which passes through the TRGATE to the loading (MOVE 3) function at berth 3 where it begins consolidation with the current vanorder. (In this case the truck storage area was empty of vans explaining why the van went immediately to a berth. If the van storage area was not depleted, the van would have been delayed in storage similar to the railcars arriving at 16- 8- 0.)
- 17- 0-21 The once empty class 3 vessel (#55903) at berth 1 consolidates all completed van (RRTR) and railcar (ORRR) shipments into a loaded vessel (#57153) and leaves the system. Then the class 1 vessel (#60635) moves from the harbor to berth 1 where it becomes an empty vessel with requirements for 3 vanorders and 1 carorder ready for matching with van and railcar cargo at the respective gates.

PORT CAPABILITY				11:51 RUN 1 - 00:00:00		PAGE 124	
EVENT TIME	TRAFFIC UNIT TYPE	IDENT.	EVENT DESCRIPTION	ENTERED SERVICE		ENTERED DELAY	
DAY HR MIN				DAY HR MIN		DAY HR MIN	
13 14 24	VANDORR12	60108	MOVES FROM TRGATE	00 00 00	10 MOVE2	00 00 00	00 15 48
13 14 24	CARGOTR4	60645	MOVES FROM TRGATE	00 00 00	10 MOVE2	00 00 00	00 15 48
13 14 33	TRUCK	62417	ORIGINALS	00 00 00	AT MOVE1	00 00 00	15 14 24
13 14 33	TRUCK	62417	MOVES FROM TRGATE	00 00 00	AT MOVE1	00 00 00	00 00 00
13 14 33	TRUCK	62417	SUBSTITUTES	00 00 00	AT STORAGE	00 00 00	00 00 00
13 14 33	CARGOTR4	62437	ORIGINALS	00 00 00	AT STORAGE	00 00 00	00 00 00
13 14 33	CARGOTR4	62437	MOVES FROM TRGATE	00 00 00	AT TRGATE	00 00 00	00 00 00
13 14 33	CARGOTR4	62437	MOVES FROM TRGATE	00 00 00	10 MOVE1	00 00 00	00 00 00
13 14 33	CARGOTR4	62437	MOVES FROM TRGATE	00 00 00	AT MOVE1	00 00 00	00 00 00
13 14 40	VANDORR13	59114	BEGINS CONSOLIDATION	00 00 00	AT MOVE1	00 00 00	00 00 00
13 14 40	VANDORR13	59114	COMPLETES CONSOLIDATION	15 13 47	AT MOVE1	15 13 47	15 14 40
13 14 40	CARGOTR4	62437	COMPLETES CONSOLIDATION	00 00 00	AT MOVE1	00 00 00	15 14 33
13 14 40	TRUCK	57729	ORIGINALS	00 00 00	AT MOVE1	00 00 00	00 00 00
13 14 40	TRUCK	57729	MOVES FROM MOVE1	00 00 00	10 MOVE1	00 00 00	00 00 00
13 14 40	TRUCK	57729	BEGINS CONSOLIDATION	00 00 00	AT MOVE1	00 00 00	00 00 00
13 14 51	SHIP	60615	ORIGINALS	00 00 00	AT HARBOR	00 00 00	00 00 00
13 14 51	VESSEL01	60615	ORIGINALS	00 00 00	AT HARBOR	00 00 00	00 00 00
13 14 51	VESSEL01	60615	BEGINS DELAY	00 00 00	AT HARBOR	00 00 00	00 00 00
13 14 54	VANDORR11	61921	BEGINS CONSOLIDATION	00 00 00	AT MOVE1	00 00 00	15 14 51
13 14 54	VANDORR11	61921	COMPLETES CONSOLIDATION	15 13 47	AT MOVE1	15 13 47	15 14 54
13 14 54	CARGOTR4	73129	COMPLETES CONSOLIDATION	00 00 00	AT MOVE1	00 00 00	15 13 47
13 14 54	TRUCK	62437	ORIGINALS	00 00 00	AT MOVE1	00 00 00	00 00 00
13 14 54	TRUCK	62437	MOVES FROM MOVE1	00 00 00	AT MOVE1	00 00 00	00 00 00
13 14 54	TRUCK	62437	BEGINS CONSOLIDATION	00 00 00	AT MOVE1	00 00 00	00 00 00
13 16 3	VANDORR12	60108	BEGINS CONSOLIDATION	00 00 00	AT MOVE1	00 00 00	15 14 54
13 16 3	VANDORR12	60108	COMPLETES CONSOLIDATION	15 14 24	AT MOVE2	15 14 24	15 16 3
13 16 3	CARGOTR4	60645	COMPLETES CONSOLIDATION	00 00 00	AT MOVE2	00 00 00	15 14 24
13 16 3	TRUCK	57633	ORIGINALS	00 00 00	AT MOVE2	00 00 00	00 00 00
13 16 3	TRUCK	57633	MOVES FROM MOVE2	00 00 00	10 MOVE2	00 00 00	00 00 00
13 16 3	TRUCK	57633	BEGINS CONSOLIDATION	00 00 00	AT MOVE2	00 00 00	00 00 00
13 16 11	TRUCK	60625	ORIGINALS	00 00 00	AT MOVE2	00 00 00	15 16 3
13 16 11	TRUCK	60625	LEAVES SYSTEM	00 00 00	AT TRGATE	00 00 00	00 00 00
13 16 53	CARGOTR4	59114	BEGINS CONSOLIDATION	00 00 00	AT MOVE4	00 00 00	00 00 00
13 16 53	CARGOTR4	59114	COMPLETES CONSOLIDATION	14 5 51	AT MOVE4	14 5 51	15 18 53
13 16 53	CARGOTR4	60625	COMPLETES CONSOLIDATION	00 00 00	AT MOVE4	00 00 00	14 5 51
13 16 53	TRUCK	60625	ORIGINALS	00 00 00	AT MOVE4	00 00 00	00 00 00
13 16 53	CARGOTR4	59114	MOVES FROM TRGATE	00 00 00	10 MOVE4	00 00 00	00 16 11
13 16 53	CARGOTR4	60625	MOVES FROM TRGATE	00 00 00	10 MOVE4	00 00 00	00 16 11
13 16 53	CARGOTR4	60625	MOVES FROM MOVE4	00 00 00	10 MOVE4	00 00 00	00 00 00
13 16 53	TRUCK	60625	BEGINS CONSOLIDATION	00 00 00	AT MOVE4	00 00 00	00 00 00
13 16 53	CARGOTR4	60625	BEGINS DELAY	00 00 00	AT MOVE4	00 00 00	15 18 53
13 16 53	TRUCK	60625	BEGINS DELAY	00 00 00	AT MOVE4	00 00 00	15 18 53
13 16 53	TRUCK	62387	ORIGINALS	00 00 00	AT TRGATE	00 00 00	00 00 00
13 16 53	TRUCK	62387	LEAVES SYSTEM	00 00 00	AT TRGATE	00 00 00	00 00 00

Figure 18 - SAMPLE TRANSIM ITERATIONS

[illegible]

Figure 23 - SAMPLE TRANSIM ITERATIONS (CONT.)

APPENDIX E

RESULTS OF SIMULATION RUN I

Simulation run I was run attempting to achieve 62.5 percent berth occupancy. The vessels arrivals were Poisson distributed with a mean interarrival time of 57 hours in order to generate about 76 vessels in the 180 day period.

Train arrivals were given a distribution of no trains arriving 25 percent of the days, one train 50 percent of the days, and two train trains arriving 25 percent of the days. Arriving trains had 30 cars 50 percent of the time and 40 cars the remainder of the time. Therefore, on the average, 35 railcars arrived each day.

Truck arrivals were Poisson distributed with a mean interarrival time of 45 minutes. The average number of truck arrivals per eight hour receiving period was expected to be 10.6.

The results for Simulation run I are shown in the accompanying figures and are summarized as follows:

- 1) Occupancy rate was $3.16/6 = 52.7$ percent.
- 2) Van cargo exported was $(1650)(18) = 29700$ long tons.
- 3) Rail cargo exported was $(547)(540) = 325080$ long tons.
- 4) Total cargo exported was $325080 + 29700 = 354,780$ long tons.
- 5) Number of vessels turned around was 69.
- 6) Percent of vessels delayed was $100 - 87.9 = 12.1$

percent.

7) Average/maximum number of vans in the storage area was 177.0/345.

8) Average van storage time was about 366.0 hours.

9) Average/maximum number of railcars in the storage area was 722/1420.

10) Average railcar storage time was about 454.3 hours.

NWS CONCORD EXPORT CAPABILITY

SIX MONTH

13MAY77

SUMMARY 1

OCCUPANCY OF ALL BERTHS (TOTAL NUMBER OF SHIPS IN PORT)

NUMBER IN SERVICE		
TOTAL NUMBER IN REPORT PERIOD 69		
MAXIMUM	6 (ON DAY	AT 0.0,
	AND	12 OTHER TIMES)
AVERAGE	3.16	
MINIMUM	(ON DAY	AT 0.0,
	AND	5 OTHER TIMES)
NUMBER	PERCENT OF REPORT PERIOD	
1 THRU	1	2.9
2 THRU	2	15.3
3 THRU	3	25.4
4 THRU	4	11.7
5 THRU	5	21.2
6 THRU	6	13.3
OVER	6	11.3

Figure 24 - OCCUPANCY OF ALL BERTHS (SIM. I)

NWS CONCORD EXPORT CAPABILITY

SIX MONTH

SUMMARY 13

TOTAL RAIL CARGO EXPORTED (UNITS OF 540 LONGTONS)

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD 547

MAXIMUM 43 (ON DAY 7 AT 1:46,
AND 2 OTHER TIMES.)

AVERAGE 14.63

MINIMUM (ON DAY 7 AT 1:46,
AND 2 OTHER TIMES.)

NUMBER PERCENT OF REPORT PERIOD

				2.0
	1	THRU	1:46	98.0
1	1	THRU	2:46	0.0
2	1	THRU	3:46	0.0
3	1	THRU	4:46	0.0
4	1	THRU	5:46	0.0
5	1	THRU	6:46	0.0
6	1	THRU	7:46	0.0
7	1	THRU	8:46	0.0
8	1	THRU	9:46	0.0
9	1	THRU	10:46	0.0
	OVER		10:46	0.0

Figure 25 - TOTAL TRUCK CARGO EXPORTED (SIM. 1)

NWS CONCORD EXPORT CAPABILITY

SIX MONTH

SUMMARY 12

TOTAL TRUCK CARGO EXPORTED (UNITS OF 13 LONGTON)

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD 1650
 MAXIMUM 187 (ON DAY 6 AT 1121)
 AVERAGE 71.13
 MINIMUM (ON DAY 5 OTHER TIMES)

NUMBER		PERCENT OF REPORT PERIOD
		3.1
1	THRU 100	7.3
1	THRU 200	26.7
2	THRU 300	2.3
3	THRU 400	0.3
4	THRU 500	0.3
5	THRU 600	0.3
6	THRU 700	0.3
7	THRU 800	0.3
8	THRU 900	0.3
9	THRU 1000	0.3
	OVER 1000	0.3

Figure 26 - TOTAL RAIL CARGO EXPORTED (SIM. I)

NWS CONCORD EXPORT CAPABILITY

SIX MONTH

13MAY7

SUMMARY 15

SHIP TIME AT ALL BERTHS (ALL SHIPS)

ELAPSED TIME (INCLUDING DELAYS)

TOTAL TIME	13391 HRS 23 MIN 47 SEC	
MAXIMUM TIME	231 HRS 22 MIN 21 SEC	(OCCURRED ON DAY , BEGINNING AT TIME)
AVERAGE TIME	194 HRS 4 MIN 42 SEC	
MINIMUM TIME	114 HRS 55 MIN 49 SEC	(OCCURRED ON DAY 121, BEGINNING AT TIME 357)

HRS	MIN	SEC		HRS	MIN	SEC	FREQUENCY	PER CENT
96	0	0	OR LESS				1	1.0
96	0	0	THRU	120	0	0	1	1.4
120	0	0	THRU	132	0	0	7	11.1
132	0	0	THRU	144	0	0	1	1.0
144	0	0	THRU	156	0	0	1	1.0
156	0	0	THRU	168	0	0	1	1.4
168	0	0	THRU	180	0	0	2	2.9
180	0	0	THRU	192	0	0	3	7.2
192	0	0	THRU	204	0	0	2	29.0
204	0	0	THRU	216	0	0	13	27.3
216	0	0	THRU	228	0	0	11	15.9
228	0	0	THRU	240	0	0	3	4.3
240	0	0	THRU	252	0	0	1	2.0
252	0	0	THRU	264	0	0	1	1.0
264	0	0	THRU	276	0	0	1	1.0
276	0	0	THRU	288	0	0	1	1.0
			MORE THAN	288	0	0	1	1.0

TOTAL NUMBER 63

Figure 27 - SHIP TIME AT ALL BERTHS (SIM. 1)

SHIP DELAY TIMES WAITING FOR BERTHS

ELAPSED TIME (INCLUDING DELAYS)

TOTAL TIME MAXIMUM TIME	395 HRS 167 HRS	47 MIN 0 MIN	38 SEC 50 SEC	FREQ	PER CENT	(OCCURRED ON DAY BEGINNING AT TIME 1240)	TOTAL DELAY MAXIMUM DELAY	585 HRS 167 HRS	47 MIN 0 MIN	38 SEC 50 SEC	FREQ	PER CENT	(OCCURRED ON DAY BEGINNING AT TIME 1240)
AVERAGE TIME MINIMUM TIME	8 HRS 0 HRS	52 MIN 0 MIN	32 SEC 0 SEC	59	87.9	C	AVERAGE DELAY MINIMUM DELAY	72 HRS 5 HRS	13 MIN 54 MIN	27 SEC 52 SEC	1	12.5	98. 1152

HRS	MIN	SEC	HRS	MIN	SEC	FREQ	PER CENT	HRS	MIN	SEC	FREQ	PER CENT
1	0	0	1	0	0	1	1.5	1	0	0	1	1.5
1	0	0	1	0	0	1	1.5	1	0	0	1	1.5
2	0	0	2	0	0	1	1.5	2	0	0	1	1.5
3	0	0	3	0	0	1	1.5	3	0	0	1	1.5
4	0	0	4	0	0	1	1.5	4	0	0	1	1.5
5	0	0	5	0	0	1	1.5	5	0	0	1	1.5
6	0	0	6	0	0	1	1.5	6	0	0	1	1.5
7	0	0	7	0	0	1	1.5	7	0	0	1	1.5
8	0	0	8	0	0	1	1.5	8	0	0	1	1.5
9	0	0	9	0	0	1	1.5	9	0	0	1	1.5
10	0	0	10	0	0	1	1.5	10	0	0	1	1.5
11	0	0	11	0	0	1	1.5	11	0	0	1	1.5
12	0	0	12	0	0	1	1.5	12	0	0	1	1.5
13	0	0	13	0	0	1	1.5	13	0	0	1	1.5
14	0	0	14	0	0	1	1.5	14	0	0	1	1.5
15	0	0	15	0	0	1	1.5	15	0	0	1	1.5
16	0	0	16	0	0	1	1.5	16	0	0	1	1.5
17	0	0	17	0	0	1	1.5	17	0	0	1	1.5
18	0	0	18	0	0	1	1.5	18	0	0	1	1.5
19	0	0	19	0	0	1	1.5	19	0	0	1	1.5
20	0	0	20	0	0	1	1.5	20	0	0	1	1.5
21	0	0	21	0	0	1	1.5	21	0	0	1	1.5
22	0	0	22	0	0	1	1.5	22	0	0	1	1.5
23	0	0	23	0	0	1	1.5	23	0	0	1	1.5
24	0	0	24	0	0	1	1.5	24	0	0	1	1.5
25	0	0	25	0	0	1	1.5	25	0	0	1	1.5
26	0	0	26	0	0	1	1.5	26	0	0	1	1.5
27	0	0	27	0	0	1	1.5	27	0	0	1	1.5
28	0	0	28	0	0	1	1.5	28	0	0	1	1.5
29	0	0	29	0	0	1	1.5	29	0	0	1	1.5
30	0	0	30	0	0	1	1.5	30	0	0	1	1.5
31	0	0	31	0	0	1	1.5	31	0	0	1	1.5
32	0	0	32	0	0	1	1.5	32	0	0	1	1.5
33	0	0	33	0	0	1	1.5	33	0	0	1	1.5
34	0	0	34	0	0	1	1.5	34	0	0	1	1.5
35	0	0	35	0	0	1	1.5	35	0	0	1	1.5
36	0	0	36	0	0	1	1.5	36	0	0	1	1.5
37	0	0	37	0	0	1	1.5	37	0	0	1	1.5
38	0	0	38	0	0	1	1.5	38	0	0	1	1.5
39	0	0	39	0	0	1	1.5	39	0	0	1	1.5
40	0	0	40	0	0	1	1.5	40	0	0	1	1.5
41	0	0	41	0	0	1	1.5	41	0	0	1	1.5
42	0	0	42	0	0	1	1.5	42	0	0	1	1.5
43	0	0	43	0	0	1	1.5	43	0	0	1	1.5
44	0	0	44	0	0	1	1.5	44	0	0	1	1.5
45	0	0	45	0	0	1	1.5	45	0	0	1	1.5
46	0	0	46	0	0	1	1.5	46	0	0	1	1.5
47	0	0	47	0	0	1	1.5	47	0	0	1	1.5
48	0	0	48	0	0	1	1.5	48	0	0	1	1.5
49	0	0	49	0	0	1	1.5	49	0	0	1	1.5
50	0	0	50	0	0	1	1.5	50	0	0	1	1.5
51	0	0	51	0	0	1	1.5	51	0	0	1	1.5
52	0	0	52	0	0	1	1.5	52	0	0	1	1.5
53	0	0	53	0	0	1	1.5	53	0	0	1	1.5
54	0	0	54	0	0	1	1.5	54	0	0	1	1.5
55	0	0	55	0	0	1	1.5	55	0	0	1	1.5
56	0	0	56	0	0	1	1.5	56	0	0	1	1.5
57	0	0	57	0	0	1	1.5	57	0	0	1	1.5
58	0	0	58	0	0	1	1.5	58	0	0	1	1.5
59	0	0	59	0	0	1	1.5	59	0	0	1	1.5
60	0	0	60	0	0	1	1.5	60	0	0	1	1.5

TOTAL NUMBER

66

NUMBER DELAYED

8

Figure 28 - SHIP DELAY TIMES (SIM. I)

NWS CONCORD EXPORT CAPABILITY

SIX MONTH

SUMMARY 1

NUMBER OF VANS IN STORAGE AREA

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD 3427
 MAXIMUM 346 (ON DAY 177 AT 1819)
 AVERAGE 177.00
 MINIMUM 0 (ON DAY 24 OTHER TIMES)

NUMBER			PERCENT OF REPORT PERIOD
			0.8
1	THRU	25	6.2
26	THRU	50	5.3
51	THRU	75	1.3
76	THRU	100	5.1
101	THRU	125	3.3
126	THRU	150	6.7
151	THRU	175	22.8
176	THRU	200	13.0
201	THRU	225	6.8
226	THRU	250	5.6
251	THRU	275	10.2
276	THRU	300	6.7
301	THRU	325	3.7
326	THRU	350	2.7
351	THRU	375	3.3
376	THRU	400	3.3
401	THRU	425	3.3
426	THRU	450	3.3
451	THRU	475	3.3
476	THRU	500	3.3
	OVER	500	3.3

Figure 29 - NUMBER OF VANS IN STORAGE AREAS (SIM. I)

NWS CONCORD EXPORT CAPABILITY

SIX MONTH

SUMMARY 26 STORAGE TIMES OF VANS

[illegible]

Figure 30 - STORAGE TIMES OF VANS (SIM. I)

SUMMARY 2

NUMBER OF TRAINS (10 CARS PER TRAIN) AT STORAGE AREA

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD 1127

MAXIMUM 142 (ON DAY 179 AT 8:00)

AVERAGE 72.2

MINIMUM (ON DAY 1 AT 1:00, AND 1 OTHER TIMES)

NUMBER		PERCENT OF REPORT PERIOD	
1 THRU	5	0.0	0.0
6 THRU	10	0.0	0.0
11 THRU	15	0.4	0.4
16 THRU	20	0.4	0.4
21 THRU	25	3.0	3.0
26 THRU	30	2.8	2.8
31 THRU	35	1.3	1.3
36 THRU	40	2.9	2.9
41 THRU	45	4.0	4.0
46 THRU	50	1.5	1.5
51 THRU	55	5.2	5.2
56 THRU	60	3.1	3.1
61 THRU	65	3.4	3.4
66 THRU	70	4.9	4.9
71 THRU	75	11.0	11.0
76 THRU	80	8.3	8.3
81 THRU	85	8.0	8.0
86 THRU	90	6.7	6.7
91 THRU	95	5.2	5.2
96 THRU	100	6.3	6.3
OVER	100	14.2	14.2

Figure 31 - NUMBER OF TRAINS AT STORAGE AREA (SIM. I)

NAS CONCORD EXPORT CAPABILITY
SUMMARY 27
STORAGE TIMES OF RAILCARS

SIX MONTH

ELAPSED TIME (INCLUDING DELAYS)

TOTAL TIME	255753 HRS	16 MIN	53 SEC	(OCCURRED ON DAY	143,	TOTAL DELAY	255753 HRS	16 MIN	53 SEC	(OCCURRED ON DAY	143,
MAXIMUM TIME	908 HRS	51 MIN	8 SEC	BEGINNING AT TIME	A.M.)	MAXIMUM DELAY	908 HRS	51 MIN	8 SEC	BEGINNING AT TIME	A.M.)
AVERAGE TIME	454 HRS	16 MIN	7 SEC	(OCCURRED ON DAY	0,	AVERAGE DELAY	454 HRS	9 MIN	43 SEC	(OCCURRED ON DAY	0,
MINIMUM TIME	0 HRS	0 MIN	0 SEC	BEGINNING AT TIME	3.0,	MINIMUM DELAY	15 HRS	47 MIN	27 SEC	BEGINNING AT TIME	0.0,
				AND	5 OTHER TIMES)						

HRS	MIN	SEC	HRS	MIN	SEC	FREQUENCY	PER CENT	HRS	MIN	SEC	FREQUENCY	PER CENT
0	0	0	0	0	0	5	1.1	0	0	0	5	1.1
24	0	0	24	0	0	5	0.9	24	0	0	5	0.9
48	0	0	48	0	0	5	0.9	48	0	0	5	0.9
72	0	0	72	0	0	3	0.7	72	0	0	3	0.7
96	0	0	96	0	0	18	3.2	96	0	0	18	3.2
120	0	0	120	0	0	34	5.3	120	0	0	34	5.3
144	0	0	144	0	0	20	3.6	144	0	0	20	3.6
168	0	0	168	0	0	11	2.0	168	0	0	11	2.0
192	0	0	192	0	0	11	2.0	192	0	0	11	2.0
216	0	0	216	0	0	2	0.4	216	0	0	2	0.4
240	0	0	240	0	0	2	0.4	240	0	0	2	0.4
264	0	0	264	0	0	3	0.5	264	0	0	3	0.5
288	0	0	288	0	0	1	0.2	288	0	0	1	0.2
312	0	0	312	0	0	1	0.2	312	0	0	1	0.2
336	0	0	336	0	0	10	1.7	336	0	0	10	1.7
360	0	0	360	0	0	1	0.2	360	0	0	1	0.2
384	0	0	384	0	0	1	0.2	384	0	0	1	0.2
408	0	0	408	0	0	17	3.0	408	0	0	17	3.0
432	0	0	432	0	0	17	3.0	432	0	0	17	3.0
456	0	0	456	0	0	38	6.7	456	0	0	38	6.7
480	0	0	480	0	0	43	8.7	480	0	0	43	8.7
504	0	0	504	0	0	57	10.1	504	0	0	57	10.1
528	0	0	528	0	0	34	6.0	528	0	0	34	6.0
552	0	0	552	0	0	33	5.9	552	0	0	33	5.9
576	0	0	576	0	0	25	4.4	576	0	0	25	4.4
600	0	0	600	0	0	17	3.0	600	0	0	17	3.0
624	0	0	624	0	0	11	1.5	624	0	0	11	1.5
648	0	0	648	0	0	11	1.5	648	0	0	11	1.5
672	0	0	672	0	0	13	1.8	672	0	0	13	1.8
696	0	0	696	0	0	17	3.0	696	0	0	17	3.0
720	0	0	720	0	0	13	3.6	720	0	0	13	3.6
MORE THAN			MORE THAN			66	11.7	MORE THAN			66	11.7

TOTAL NUMBER

563

NUMBER DELAYED

557

Figure 32 - STORAGE TIMES OF RAILCARS (SIM. I)

APPENDIX F

RESULTS OF SIMULATION RUN II

Simulation run II was a run attempting to achieve 62.5 percent berth occupancy. The vessel arrivals were Poisson distributed with a mean interarrival time of 57 hours in order to generate about 70 vessels in the 180 day period.

Train arrivals remained the same as for simulation run I with no trains arriving 25 percent of the days, one train arriving 50 percent of the days and two trains arriving 25 percent of the days. Arriving trains had 30 cars 50 percent of the time and 40 cars the remainder of the time. Therefore, on the average, 35 railcars arrived each day.

Truck arrivals were Poisson distributed with a mean interarrival time of 45 minutes during normal operations. When the number of vans in the storage area was less than 10, the mean interarrival time was 15 minutes and when the number of vans in the storage area was greater than 150, the mean interarrival time was 75 minutes. This was the first of the five simulation runs to use the non-homogeneous arrival distribution. The average number of truck arrivals per eight hour receiving period was expected to be 10.6.

The results of simulation run II are shown in the accompanying figures and are summarized as follows:

- 1) Occupancy rate was $3.62/6 = 60.3$ percent.
- 2) Van cargo exported was $(1929)(18) = 34722$ long tons.
- 3) Rail cargo exported was $(597)(540) = 322,380$ long

tons.

4) Total cargo exported was $322380 + 34722 = 357,102$ long tons.

5) Number of vessels turned around was 77.

6) Percent of vessels delayed was $100 - 64.9 = 35.1$ percent.

7) Average/maximum number of vans in the storage area was $98.0/220$.

8) Average van storage time was about 204.5 hours.

9) Average/maximum number of railcars in the storage area was $114.3/500$.

10) Average railcar storage time was about 78.5 hours.

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS

17MAY77

SUMMARY 10

OCCUPANCY OF ALL BERTHS (TOTAL NUMBER OF SHIPS IN PORT)

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD 77

MAXIMUM 5 (ON DAY 1 AT 8 C,
AND 36 OTHER TIMES)

AVERAGE 3.62

MINIMUM 0 (ON DAY 0 AT 0 C,
AND 2 OTHER TIMES)

NUMBER		PERCENT OF REPORT PERIOD
1		0.9
1 THRU	1	10.1
2 THRU	2	22.7
3 THRU	3	22.0
4 THRU	4	6.3
5 THRU	5	7.0
6 THRU	6	28.0
OVER	6	0.0

figure 33 - OCCUPANCY OF ALL BERTHS (SIM. II)

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS

17MAY77

SUMMARY 12

TOTAL TRUCK CARGO EXPORTED (UNITS OF 18 LONGTON)

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD 1929

MAXIMUM 200 (ON DAY 92 AT 330)

AVERAGE 83.44

MINIMUM 0 (ON DAY 0 AT 0.0,
AND 2 OTHER TIMES)

NUMBER PERCENT OF REPORT PERIOD

0	1.0
1 THRU 100	56.1
101 THRU 200	31.6
201 THRU 300	1.3
301 THRU 400	0.0
401 THRU 500	0.0
501 THRU 600	0.0
601 THRU 700	0.0
701 THRU 800	0.0
801 THRU 900	0.0
901 THRU 1000	0.0
OVER 1000	0.0

Figure 34 - TOTAL TRUCK CARGO EXPORTED (SIM. II)

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS 17MAY77

SUMMARY 13

TOTAL RAIL CARGO EXPORTED (UNITS OF 540 LONGTONS)

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD	597
MAXIMUM	50 (ON DAY 178 AT 123)
AVERAGE	16.99
MINIMUM	0 (ON DAY 0 AT 0 0)

NUMBER	PERCENT OF REPORT PERIOD
0	0.6
1 THRU 100	99.4
101 THRU 200	0.0
201 THRU 300	0.0
301 THRU 400	0.0
401 THRU 500	0.0
501 THRU 600	0.0
601 THRU 700	0.0
701 THRU 800	0.0
801 THRU 900	0.0
901 THRU 1000	0.0
OVER 1000	0.0

Figure 35 - TOTAL RAIL CARGO EXPORTED (SIM. II)

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS

17MAY7

SUMMARY 15

SHIP TIME AT ALL BERTHS (ALL SHIPS)

ELAPSED TIME (INCLUDING DELAYS)

TOTAL TIME	15195 HRS 26 MIN 22 SEC	
MAXIMUM TIME	233 HRS 22 MIN 10 SEC	(OCCURRED ON DAY 108, BEGINNING AT TIME 1342)
AVERAGE TIME	197 HRS 20 MIN 36 SEC	
MINIMUM TIME	105 HRS 8 MIN 59 SEC	(OCCURRED ON DAY 142, BEGINNING AT TIME 2341)

HRS	MIN	SEC		HRS	MIN	SEC	FREQUENCY	PER CENT
96	0	0	OR LESS				1	0.0
96	0	0	THRU	108	0	0	1	1.3
108	0	0	THRU	120	0	0	5	7.3
120	0	0	THRU	132	0	0	1	1.3
132	0	0	THRU	144	0	0	0	0.0
144	0	0	THRU	156	0	0	0	0.0
156	0	0	THRU	168	0	0	3	4.0
168	0	0	THRU	180	0	0	2	2.6
180	0	0	THRU	192	0	0	4	5.2
192	0	0	THRU	204	0	0	22	28.6
204	0	0	THRU	216	0	0	26	33.8
216	0	0	THRU	228	0	0	13	16.9
228	0	0	THRU	240	0	0	2	2.6
240	0	0	THRU	252	0	0	0	0.0
252	0	0	THRU	264	0	0	0	0.0
264	0	0	THRU	276	0	0	0	0.0
276	0	0	THRU	288	0	0	0	0.0
			MORE THAN	288	0	0	0	0.0
TOTAL NUMBER							77	

Figure 36 - SHIP TIME AT ALL BERTHS (SIM. II)

NWS CONCORD EXPORT CAPABILITY SIX MONTHS
SUMMARY 14 SHIP DELAY TIMES WAITING FOR BERTHS

ELAPSED TIME (INCLUDING DELAYS)										DELAY TIME									
TOTAL TIME		2120 HRS 43 MIN 47 SEC		TOTAL CF LAY		2120 HRS 43 MIN 47 SEC		(OCCURRED ON DAY BEGINNING AT TIME 1225)		21		(OCCURRED ON DAY BEGINNING AT TIME 1225)		21		(OCCURRED ON DAY BEGINNING AT TIME 1225)		21	
MAXIMUM TIME		164 HRS 6 MIN 30 SEC		MAXIMUM DELAY		164 HRS 6 MIN 30 SEC		AVERAGE DELAY		76 HRS 32 MIN 44 SEC		AVERAGE DELAY		76 HRS 32 MIN 44 SEC		MINIMUM DELAY		2 HRS 30 MIN 58 SEC	
AVERAGE TIME		27 HRS 32 MIN 31 SEC		HRS MIN SEC		HRS MIN SEC		HRS MIN SEC		HRS MIN SEC		HRS MIN SEC		HRS MIN SEC		HRS MIN SEC		HRS MIN SEC	
MINIMUM TIME		0 HRS 0 MIN 0 SEC		FREQ		FREQ		FREQ		FREQ		FREQ		FREQ		FREQ		FREQ	

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS 17MAY77

SUMMARY 1

NUMBER OF VANS IN STORAGE AREA

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD 4071

MAXIMUM 226 (ON DAY 158 AT 1522)

AVERAGE 28.01

MINIMUM 0 (ON DAY 0 AT 8 0,
AND 52 OTHER TIMES)

NUMBER		PERCENT OF REPORT PERIOD
	0	0.0
1 THRU	25	19.4
26 THRU	50	8.6
51 THRU	75	9.0
76 THRU	100	11.0
101 THRU	125	10.2
126 THRU	150	15.1
151 THRU	175	10.3
176 THRU	200	3.7
201 THRU	225	2.6
226 THRU	250	0.1
251 THRU	275	0.0
276 THRU	300	0.0
301 THRU	325	0.0
326 THRU	350	0.0
351 THRU	375	0.0
376 THRU	400	0.0
OVER	400	0.0

Figure 38 - NUMBER OF VANS IN STORAGE AREAS (SIM. II,

NWS CONCORD EXPORT CAPABILITY SIX MONTHS
SUMMARY 20 STORAGE TIMES OF VANS

ELAPSED TIME (INCLUDING DELAYS)

TOTAL TIME MAXIMUM TIME	415993 HRS 24 MIN 23 SEC					(OCCURRED ON DAY 136 BEGINNING AT TIME 1520)					TOTAL DFLAY 415992 HRS 24 MIN 23 SEC					(OCCURRED ON DAY 136 BEGINNING AT TIME 1520)				
	0	48	72	96	120	144	168	192	216	240	0	48	72	96	120	144	168	192	216	240
AVERAGE TIME	0	48	72	96	120	144	168	192	216	240	0	48	72	96	120	144	168	192	216	240
MINIMUM TIME	0	48	72	96	120	144	168	192	216	240	0	48	72	96	120	144	168	192	216	240

HRS MIN SEC	HRS 24 MIN 23 SEC					HRS 24 MIN 23 SEC					HRS 24 MIN 23 SEC					HRS 24 MIN 23 SEC				
	0	48	72	96	120	144	168	192	216	240	0	48	72	96	120	144	168	192	216	240
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
168	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
192	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
216	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
264	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
288	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
312	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
336	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
360	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
384	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
408	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
432	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
456	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
480	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
504	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
528	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
552	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
576	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
624	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
648	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
672	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
696	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TOTAL NUMBER 2035

NUMBER OFPLAYED

2020

Figure 39 - STORAGE TIMES OF VANS (SIM. II)

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS

17MAY77

SUMMARY 2

NUMBER OF TRAINS (10 CARS PER TRAIN) AT STORAGE AREA

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD 1251
 MAXIMUM 51 (ON DAY 1 AT 8 0)

AVERAGE 11.43
 MINIMUM 0 (ON DAY 1 AT 8 0,
 AND 135 OTHER TIMES)

NUMBER		PERCENT OF REPORT PERIOD
0		24.7
1 THRU	5	20.9
6 THRU	10	14.0
11 THRU	15	8.4
16 THRU	20	7.4
21 THRU	25	8.8
26 THRU	30	8.3
31 THRU	35	2.4
36 THRU	40	2.1
41 THRU	45	1.9
46 THRU	50	1.0
51 THRU	55	0.0
56 THRU	60	0.0
61 THRU	65	0.0
66 THRU	70	0.0
71 THRU	75	0.0
76 THRU	80	0.0
81 THRU	85	0.0
86 THRU	90	0.0
91 THRU	95	0.0
96 THRU	100	0.0
OVER	100	0.0

Figure 40 - NUMBER OF TRAINS AT STORAGE AREA (SIM. II)

NWS CONCORD EXPORT CAPABILITY SIX MONTHS
SUMMARY 27 STORAGE TIMES OF RAILCARS

ELAPSED TIME (INCLUDING DELAYS)

TOTAL TIME		49051 HRS 28 MIN 57 SEC				(OCCURRED ON DAY 160)			
MAXIMUM TIME		281 HRS 30 MIN 4 SEC				(BEGINNING AT TIME 8 0)			
AVERAGE TIME		78 HRS 28 MIN 57 SEC				(OCCURRED ON DAY 2)			
MINIMUM TIME		0 HRS 0 MIN 0 SEC				(BEGINNING AT TIME 8 0 AND 127 OTHER TIMES)			
		TOTAL DELAY				AVERAGE DELAY			
		MAXIMUM DELAY				MINIMUM DELAY			
		HRS MIN SEC				HRS MIN SEC			
		HRS MIN SEC				HRS MIN SEC			
		HRS MIN SEC				HRS MIN SEC			
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APPENDIX G

RESULTS OF SIMULATION RUN III

Simulation run III was run attempting to achieve 62.5 percent berth occupancy. The vessel arrivals were Poisson distributed with a mean interarrival of 57 hours in order to generate about 76 vessels in the 180 day period. This run was given a new seed to increase the randomness of the results.

Train arrivals were given a distribution of no trains arriving 25 percent of the days, one train 50 percent of the days, and two trains arriving 25 percent of the days. Arriving trains had 30 cars 50 percent of the time and 40 cars the remainder of the time. Therefore, on the average, 35 railcars arrived each day.

Truck arrivals were Poisson distributed with a mean interarrival time of 45 minutes during normal operations. When the number of vans in the storage area was less than 10, the mean interarrival time was 15 minutes and when the number of vans in the storage area was greater than 150, the mean interarrival time was 75 minutes. The average number of truck arrivals per eight hour receiving period was expected to be 10.6.

The results for simulation run III are shown in the accompanying figures and are summarized as follows:

- 1) Occupancy rate was $4.16/6 = 69.3$ percent.
- 2) Van cargo exported was $(2253)(13) = 40554$ long tons.

3) Rail cargo exported was $(659)(540) = 356860$ long tons.

4) Total cargo exported was $356860 + 40554 = 397,414$ long tons.

5) Number of vessels turned around was 90.

6) Percent of vessels delayed was $100 - 66.3 = 33.7$ percent.

7) Average/maximum number of vans in the storage area was $54.9/185$.

8) Average van storage time was about 96.0 hours.

9) Average/maximum number of railcars in the storage area was $136/650$.

10) Average railcar storage time was about 75.0 hours.

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS

18MAY77

SUMMARY 10

OCCUPANCY OF ALL BERTHS (TOTAL NUMBER OF SHIPS IN PORT)

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD 90

MAXIMUM 6 (ON DAY 0 AT 8 0,
AND 41 OTHER TIMES)

AVERAGE 4.16

MINIMUM 0 (ON DAY 0 AT 0 0,
AND 2 OTHER TIMES)

NUMBER PERCENT OF REPORT PERIOD

0 1.6

1 THRU 1 5.8

2 THRU 2 11.6

3 THRU 3 16.1

4 THRU 4 20.1

5 THRU 5 23.2

6 THRU 6 32.6

OVER 6 0.0

Figure 42 - OCCUPANCY OF ALL BERTHS (SIM. III)

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS

18M

SUMMARY 12

TOTAL TRUCK CARGO EXPORTED (UNITS OF 18 LONGTON)

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD	2253
MAXIMUM	225 (ON DAY 13 AT 2042)
AVERAGE	34.81
MINIMUM	0 (ON DAY 3 AT 00, AND 2 OTHER TIMES)

NUMBER	PERCENT OF REPORT PERIOD
0	1.7
1 THRU 100	51.8
101 THRU 200	44.5
201 THRU 300	2.0
301 THRU 400	0.0
401 THRU 500	0.0
501 THRU 600	0.0
601 THRU 700	0.0
701 THRU 800	0.0
801 THRU 900	0.0
901 THRU 1000	0.0
OVER 1000	0.0

Figure 43 - TOTAL TRUCK CARGO EXPORTED (SIM. III)

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS

18MAY77

SUMMARY 13

TOTAL RAIL CARGO EXPORTED (UNITS OF 540 LONGTONS)

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD 659

MAXIMUM 46 (ON DAY 16 AT 1730)

AVERAGE 17.05

MINIMUM 0 (ON DAY 0 AT 0 0)

NUMBER	PERCENT OF REPORT PERIOD
0	0.6
1 THRU 100	99.4
101 THRU 200	0.0
201 THRU 300	0.0
301 THRU 400	0.0
401 THRU 500	0.0
501 THRU 600	0.0
601 THRU 700	0.0
701 THRU 800	0.0
801 THRU 900	0.0
901 THRU 1000	0.0
OVER 1000	0.0

Figure 44 - TOTAL RAIL CARGO EXPORTED (SIM. III)

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS

18MAY7

SUMMARY 15

SHIP TIME AT ALL BERTHS (ALL SHIPS)

ELAPSED TIME (INCLUDING DELAYS)

TOTAL TIME 17866 HRS 27 MIN 25 SEC
 MAXIMUM TIME 238 HRS 15 MIN 59 SEC (OCCURRED ON DAY 51,
 BEGINNING AT TIME 1035)
 AVERAGE TIME 198 HRS 30 MIN 13 SEC
 MINIMUM TIME 108 HRS 31 MIN 7 SEC (OCCURRED ON DAY 124,
 BEGINNING AT TIME 1024)

HRS	MIN	SEC		HRS	MIN	SEC	FREQUENCY	PER CENT
96	0	0	OR LESS				0	0.0
96	0	0	THRU	108	0	0	0	0.0
108	0	0	THRU	120	0	0	5	5.5
120	0	0	THRU	132	0	0	1	1.1
132	0	0	THRU	144	0	0	0	0.0
144	0	0	THRU	156	0	0	0	0.0
156	0	0	THRU	168	0	0	4	4.4
168	0	0	THRU	180	0	0	0	0.0
180	0	0	THRU	192	0	0	5	5.6
192	0	0	THRU	204	0	0	33	33.6
204	0	0	THRU	216	0	0	24	26.7
216	0	0	THRU	228	0	0	18	20.0
228	0	0	THRU	240	0	0	1	1.1
240	0	0	THRU	252	0	0	0	0.0
252	0	0	THRU	264	0	0	0	0.0
264	0	0	THRU	276	0	0	0	0.0
276	0	0	THRU	288	0	0	0	0.0
			MORE THAN	299	0	0	0	0.0
TOTAL NUMBER							90	

Figure 45 - SHIP TIME AT ALL BERTHS (SIM. III)

SHIP DELAY TIMES WAITING FOR CERTS

PLASSED TIME (INCLUDING DELAYS)										TOTAL DELAY										TOTAL DELAYED									
TOTAL TIME		137 HRS 51 MIN 52 SEC		187 HRS 38 MIN 11 SEC		(OCCURRED ON DAY 1239)		30		TOTAL DELAY		183 HRS 51 MIN 52 SEC		(OCCURRED ON DAY 1239)		0		TOTAL DELAY		187 HRS 38 MIN 11 SEC		(OCCURRED ON DAY 1239)		17					
MAXIMUM TIME		187 HRS 38 MIN 11 SEC		63 HRS 24 MIN 33 SEC		(OCCURRED ON DAY 1239)		17		AVERAGE DELAY		3 HRS 9 MIN 2 SEC		(OCCURRED ON DAY 1239)		17		MINIMUM DELAY		3 HRS 9 MIN 2 SEC		(OCCURRED ON DAY 1239)		17					
MINIMUM TIME		0 HRS 3 MIN 0 SEC		0 HRS 3 MIN 0 SEC		(OCCURRED ON DAY 1239)		17		MINIMUM DELAY		0 HRS 3 MIN 0 SEC		(OCCURRED ON DAY 1239)		17		0 HRS 3 MIN 0 SEC		0 HRS 3 MIN 0 SEC		(OCCURRED ON DAY 1239)		17					
		AND 50 OTHER TIMES		AND 50 OTHER TIMES		AND 50 OTHER TIMES		AND 50 OTHER TIMES																					
HRS	MIN	SEC	HRS	MIN	SEC	FREQUENCY	PER CENT	HRS	MIN	SEC	HRS	MIN	SEC	FREQUENCY	PER CENT	HRS	MIN	SEC	HRS	MIN	SEC	FREQUENCY	PER CENT						
0	0	0	0	0	0	57	46.1	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0.0							
1	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0.0	2	0	0	0	0	0	0.0							
2	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0.0	4	0	0	0	0	0	0.0							
3	0	0	0	0	0	1	1.2	0	0	0	0	0	0	0	0.0	6	0	0	0	0	0	0.0							
4	0	0	0	0	0	1	1.2	0	0	0	0	0	0	0	0.0	8	0	0	0	0	0	0.0							
5	0	0	0	0	0	0	0.0	19	0	0	0	0	0	0	0.0	10	0	0	0	0	0	0.0							
6	0	0	0	0	0	0	0.0	12	0	0	0	0	0	0	0.0	12	0	0	0	0	0	0.0							
7	0	0	0	0	0	0	0.0	14	0	0	0	0	0	0	0.0	14	0	0	0	0	0	0.0							
8	0	0	0	0	0	0	0.0	16	0	0	0	0	0	0	0.0	16	0	0	0	0	0	0.0							
9	0	0	0	0	0	0	0.0	18	0	0	0	0	0	0	0.0	19	0	0	0	0	0	0.0							
10	0	0	0	0	0	0	0.0	20	0	0	0	0	0	0	0.0	20	0	0	0	0	0	0.0							
11	0	0	0	0	0	1	1.2	22	0	0	0	0	0	0	0.0	22	0	0	0	0	0	0.0							
12	0	0	0	0	0	1	1.2	24	0	0	0	0	0	0	0.0	24	0	0	0	0	0	0.0							
13	0	0	0	0	0	1	1.2	26	0	0	0	0	0	0	0.0	26	0	0	0	0	0	0.0							
14	0	0	0	0	0	1	1.2	28	0	0	0	0	0	0	0.0	28	0	0	0	0	0	0.0							
15	0	0	0	0	0	1	1.2	30	0	0	0	0	0	0	0.0	30	0	0	0	0	0	0.0							
16	0	0	0	0	0	1	1.2	32	0	0	0	0	0	0	0.0	32	0	0	0	0	0	0.0							
17	0	0	0	0	0	1	1.2	34	0	0	0	0	0	0	0.0	34	0	0	0	0	0	0.0							
18	0	0	0	0	0	1	1.2	36	0	0	0	0	0	0	0.0	36	0	0	0	0	0	0.0							
19	0	0	0	0	0	2	2.4	38	0	0	0	0	0	0	0.0	38	0	0	0	0	0	0.0							
20	0	0	0	0	0	2	2.4	40	0	0	0	0	0	0	0.0	40	0	0	0	0	0	0.0							
21	0	0	0	0	0	21	24.4	42	0	0	0	0	0	0	0.0	42	0	0	0	0	0	0.0							
MORE THAN			20			46			46			46			46			46			46			46					
			21			46			46			46			46			46			46			46					
			22			46			46			46			46			46			46			46					
			23			46			46			46			46			46			46			46					
			24			46			46			46			46			46			46			46					
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			27			46			46			46			46			46			46			46					
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			81			46			46			46			46			46			46			46					
			82			46			46			46			46			46			46			46					
			83			46			46			46			46			46			46			46					
			84			46			46			46			46			46			46			46					
			85			46			46			46			46			46			46			46					
			86			46			46			46			46			46			46			46					
			87			46			46			46			46			46			46			46					
			88			46			46			46			46			46			46			46					
			89			46			46			46			46			46			46			46					
			90			46			46			46			46			46			46			46					
			91			46			46			46			46			46			46			46					
			92			46			46			46			46			46			46			46					
			93			46			46			46			46			46			46			46					
			94			46			46			46			46			46			46			46					
			95			46			46			46			46			46			46			46					
			96			46			46			46			46			46			46			46					
			97			46			46			46			46			46			46			46					
			98			46			46			46			46			46			46			46					
			99			46			46			46			46			46			46			46					
			100			46			46			46			46			46			46			46					
			101			46			46			46			46			46			46			46					
			102			46			46			46			46			46			46			46					
			103			46			46			46			46			46			46			46					
			104			46			46			46			46			46			46			46					
			105			46			46			46			46			46			46			46					
			106			46			46			46			46			46			46			46					
			107			46			46			46			46			46			46			46					
			108			46			46			46			46			46			46			46					
			109			46			46																				

Figure 46 - SHIP DELAY TIMES (SIM. III)

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS

18MAY7

SUMMARY 1

NUMBER OF VANS IN STORAGE AREA

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD 4627

MAXIMUM 185 (ON DAY 158 AT 1522)

AVERAGE 54.94

MINIMUM 0 (ON DAY 0 AT 8 0,
AND 172 OTHER TIMES)

NUMBER PERCENT OF REPORT PERIOD

	0	3.8
1 THRU	25	32.7
26 THRU	50	20.6
51 THRU	75	17.8
76 THRU	100	6.8
101 THRU	125	6.1
126 THRU	150	5.9
151 THRU	175	5.4
176 THRU	200	0.9
201 THRU	225	0.0
226 THRU	250	0.0
251 THRU	275	0.0
276 THRU	300	0.0
301 THRU	325	0.0
326 THRU	350	0.0
351 THRU	375	0.0
376 THRU	400	0.0
OVER	400	0.0

Figure 47 - NUMBER OF VANS IN STORAGE AREAS (SIM. III)

NWS CONCORD EXPORT CAPABILITY SIX MONTHS
SUMMARY 26
STORAGE TIMES OF VANS

ELAPSED TIME (INCLUDING DELAYS)										DELAY TIME													
TOTAL TIME		22151 HRS 53 MIN 2 SEC		506 HRS 33 MIN 21 SEC		TOTAL DELAY		22151 HRS 58 MIN 8 SEC		506 HRS 33 MIN 21 SEC		AVERAGE DELAY		98 HRS 23 MIN 4 SEC		MINIMUM DELAY		0 HRS 6 MIN 59 SEC		(OCCURRED ON DAY BEGINNING AT TIME 148.1046)		(OCCURRED ON DAY BEGINNING AT TIME 119.913)	
MAXIMUM TIME		26 HRS 3 MIN 42 SEC		0 HRS 3 MIN 3 SEC		AVERAGE TIME		26 HRS 3 MIN 42 SEC		0 HRS 3 MIN 3 SEC		MINIMUM TIME		26 HRS 3 MIN 42 SEC		0 HRS 3 MIN 3 SEC		(OCCURRED ON DAY BEGINNING AT TIME 148.1046)		(OCCURRED ON DAY BEGINNING AT TIME 119.913)			
HRS	MIN	SEC	HRS	MIN	SEC	HRS	MIN	SEC	HRS	MIN	SEC	HRS	MIN	SEC	HRS	MIN	SEC	FREQUENCY	PER CENT	FREQUENCY	PER CENT		
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	710	0.0	0	0.0		
24	0	0	0	0	0	24	0	0	0	0	0	24	0	0	0	0	0	359	31.4	359	31.4		
48	0	0	0	0	0	48	0	0	0	0	0	48	0	0	0	0	0	253	15.9	253	15.9		
72	0	0	0	0	0	72	0	0	0	0	0	72	0	0	0	0	0	200	11.2	200	11.2		
96	0	0	0	0	0	96	0	0	0	0	0	96	0	0	0	0	0	169	8.9	169	8.9		
120	0	0	0	0	0	120	0	0	0	0	0	120	0	0	0	0	0	144	7.5	144	7.5		
144	0	0	0	0	0	144	0	0	0	0	0	144	0	0	0	0	0	61	5.6	61	5.6		
168	0	0	0	0	0	168	0	0	0	0	0	168	0	0	0	0	0	60	2.7	60	2.7		
192	0	0	0	0	0	192	0	0	0	0	0	192	0	0	0	0	0	44	1.9	44	1.9		
216	0	0	0	0	0	216	0	0	0	0	0	216	0	0	0	0	0	21	1.4	21	1.4		
240	0	0	0	0	0	240	0	0	0	0	0	240	0	0	0	0	0	42	1.9	42	1.9		
264	0	0	0	0	0	264	0	0	0	0	0	264	0	0	0	0	0	27	1.2	27	1.2		
288	0	0	0	0	0	288	0	0	0	0	0	288	0	0	0	0	0	18	0.8	18	0.8		
312	0	0	0	0	0	312	0	0	0	0	0	312	0	0	0	0	0	23	1.0	23	1.0		
336	0	0	0	0	0	336	0	0	0	0	0	336	0	0	0	0	0	14	0.6	14	0.6		
360	0	0	0	0	0	360	0	0	0	0	0	360	0	0	0	0	0	19	0.8	19	0.8		
384	0	0	0	0	0	384	0	0	0	0	0	384	0	0	0	0	0	42	2.2	42	2.2		
408	0	0	0	0	0	408	0	0	0	0	0	408	0	0	0	0	0	23	1.3	23	1.3		
432	0	0	0	0	0	432	0	0	0	0	0	432	0	0	0	0	0	13	0.7	13	0.7		
456	0	0	0	0	0	456	0	0	0	0	0	456	0	0	0	0	0	10	0.6	10	0.6		
480	0	0	0	0	0	480	0	0	0	0	0	480	0	0	0	0	0	0	0	0	0.0		
504	0	0	0	0	0	504	0	0	0	0	0	504	0	0	0	0	0	0	0	0	0.0		
528	0	0	0	0	0	528	0	0	0	0	0	528	0	0	0	0	0	0	0	0	0.0		
552	0	0	0	0	0	552	0	0	0	0	0	552	0	0	0	0	0	0	0	0	0.0		
576	0	0	0	0	0	576	0	0	0	0	0	576	0	0	0	0	0	0	0	0	0.0		
600	0	0	0	0	0	600	0	0	0	0	0	600	0	0	0	0	0	0	0	0	0.0		
624	0	0	0	0	0	624	0	0	0	0	0	624	0	0	0	0	0	0	0	0	0.0		
648	0	0	0	0	0	648	0	0	0	0	0	648	0	0	0	0	0	0	0	0	0.0		
672	0	0	0	0	0	672	0	0	0	0	0	672	0	0	0	0	0	0	0	0	0.0		
696	0	0	0	0	0	696	0	0	0	0	0	696	0	0	0	0	0	0	0	0	0.0		
MORE THAN						MORE THAN						MORE THAN						MORE THAN					
TOTAL						TOTAL						TOTAL						TOTAL					
2313						2313						2313						2313					
2258						2258						2258						2258					

Figure 48 - STORAGE TIMES OF VANS (SIM. III)

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS 18MAY7

SUMMARY 2

NUMBER OF TRAINS (10 CARS PER TRAIN) AT STORAGE AREA

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD 1347

MAXIMUM 65 (ON DAY 166 AT 8 0)

AVERAGE 13.64

MINIMUM 0 (ON DAY 0 AT 8 0,
AND 203 OTHER TIMES)

NUMBER		PERCENT OF REPORT PERIOD
	0	36.7
1 THRU	5	19.7
6 THRU	10	12.9
11 THRU	15	4.2
16 THRU	20	2.3
21 THRU	25	0.9
26 THRU	30	2.9
31 THRU	35	3.3
36 THRU	40	1.4
41 THRU	45	1.9
46 THRU	50	1.7
51 THRU	55	4.3
56 THRU	60	4.3
61 THRU	65	3.1
66 THRU	70	0.0
71 THRU	75	0.0
76 THRU	80	0.0
81 THRU	85	0.0
86 THRU	90	0.0
91 THRU	95	0.0
96 THRU	100	0.0
	OVER 100	0.0

Figure 49 - NUMBER OF TRAINS AT STORAGE AREA (SIM. III)

AMS CONCORD EXPORT CAPABILITY

SIX MONTHS

SUMMARY 27 STORAGE TIMES OF RAILCARS

ELAPSED TIME (INCLUDING DELAYS)

TOTAL TIME		50524 HRS 25 MIN 50 SEC				158. (OCCURRED ON DAY				158. (OCCURRED ON DAY			
MAXIMUM TIME		170 HRS 22 MIN 34 SEC				8 0) BEGINNING AT TIME				8 0) BEGINNING AT TIME			
AVERAGE TIME		75 HRS 1 MIN 24 SEC				0. (OCCURRED ON DAY				0. (OCCURRED ON DAY			
MINIMUM TIME		0 HRS 0 MIN 0 SEC				ANC 201 OTHER TIMES)				8 0) BEGINNING AT TIME			
		HRS MIN SEC		HRS MIN SEC		FREQUENCY		PER CENT		HRS MIN SEC		FREQUENCY	
0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	117	17.4	11.3	0	0	0	117	24.8
48	0	0	0	0	0	68	10.1	10.1	0	0	0	68	16.1
72	0	0	0	0	0	39	5.6	5.6	0	0	0	39	14.4
96	0	0	0	0	0	34	5.1	5.1	0	0	0	34	8.1
120	0	0	0	0	0	15	2.2	2.2	0	0	0	15	7.2
144	0	0	0	0	0	10	1.5	1.5	0	0	0	10	3.2
168	0	0	0	0	0	17	2.5	2.5	0	0	0	17	2.1
192	0	0	0	0	0	15	2.2	2.2	0	0	0	15	3.6
216	0	0	0	0	0	3	0.4	0.4	0	0	0	3	3.2
240	0	0	0	0	0	2	0.3	0.3	0	0	0	2	0.6
264	0	0	0	0	0	4	0.6	0.6	0	0	0	4	0.4
288	0	0	0	0	0	19	2.8	2.8	0	0	0	19	0.8
312	0	0	0	0	0	34	5.1	5.1	0	0	0	34	4.0
336	0	0	0	0	0	16	2.4	2.4	0	0	0	16	7.2
360	0	0	0	0	0	7	0.4	0.4	0	0	0	7	3.4
384	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.6
408	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0
432	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0
456	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0
480	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0
504	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0
528	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0
552	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0
576	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0
600	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0
624	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0
648	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0
672	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0
696	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0.0
MORE THAN		HRS MIN SEC		HRS MIN SEC		FREQUENCY		PER CENT		HRS MIN SEC		FREQUENCY	
		0		0		0		0.0		0		0	
		24		0		0		0.0		0		0	
		48		0		0		0.0		0		0	
		72		0		0		0.0		0		0	
		96		0		0		0.0		0		0	
		120		0		0		0.0		0		0	
		144		0		0		0.0		0		0	
		168		0		0		0.0		0		0	
		192		0		0		0.0		0		0	
		216		0		0		0.0		0		0	
		240		0		0		0.0		0		0	
		264		0		0		0.0		0		0	
		288		0		0		0.0		0		0	
		312		0		0		0.0		0		0	
		336		0		0		0.0		0		0	
		360		0		0		0.0		0		0	
		384		0		0		0.0		0		0	
		408		0		0		0.0		0		0	
		432		0		0		0.0		0		0	
		456		0		0		0.0		0		0	
		480		0		0		0.0		0		0	
		504		0		0		0.0		0		0	
		528		0		0		0.0		0		0	
		552		0		0		0.0		0		0	
		576		0		0		0.0		0		0	
		600		0		0		0.0		0		0	
		624		0		0		0.0		0		0	
		648		0		0		0.0		0		0	
		672		0		0		0.0		0		0	
		696		0		0		0.0		0		0	
		720		0		0		0.0		0		0	
		720		0		0		0.0		0		0	

TOTAL NUMBER

673

NUMBER DELAYED

471

Figure 50 - STORAGE TIMES OF RAILCARS (SIM. III)

APPENDIX H

RESULTS OF SIMULATION RUN IV

Simulation run IV was run attempting to achieve 90 percent berth occupancy. The vessel arrivals were Poisson distributed with a mean interarrival time of 37 hours in order to generate about 117 vessels in the 180 day period.

Train arrivals were given a distribution of no trains arriving 25 percent of the days, one train 50 percent of the days, and two trains arriving 25 percent of the days. Arriving trains had 50 cars 40 percent of the time and 60 cars the remainder of the time. Therefore, on the average, 56 railcars arrived each day.

Truck arrivals were Poisson distributed with a mean interarrival time of 30 minutes during normal operations. When the number of vans in the storage area was less than 10, the mean interarrival time was 10 minutes and when the number of vans in the storage area was greater than 150, the mean interarrival time was 50 minutes. The average number of truck arrivals per eight hour receiving period was expected to be 16.8.

The results for simulation run IV are shown in the accompanying figures and are summarized as follows:

- 1) Occupancy rate was $5.99/6 = 99.8$ percent.
- 2) War cargo exported was $(3132)(18) = 56376$ long tons.
- 3) Rail cargo exported was $(1026)(540) = 554040$ long tons.

4) Total cargo exported was $554040 + 56376 = 610,416$ long tons.

5) Number of vessels turned around was 127.

6) Percent of vessels delayed was $100 - 100.0 = 0.0$ percent.

7) Average/maximum number of vans in the storage area was $55.2/150$.

8) Average van storage time was about 72.2 hours.

9) Average/maximum number of railcars in the storage area was $105/520$.

10) Average railcar storage time was about 42.5 hours.

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS

19MAY77

PRIMARY 10

OCCUPANCY OF ALL BERTHS (TOTAL NUMBER OF SHIPS IN PORT)

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD 127

MAXIMUM 6 (ON DAY 0 AT 8 0,
AND 127 OTHER TIMES)

AVERAGE 5.99

MINIMUM 0 (ON DAY 0 AT 0 0)

NUMBER		PERCENT OF REPORT PERIOD
0		0.2
1 THRU	1	0.0
2 THRU	2	0.0
3 THRU	3	0.0
4 THRU	4	0.0
5 THRU	5	0.0
6 THRU	6	99.8
OVER	6	0.0

Figure 51 - OCCUPANCY OF ALL BERTHS (SIM. IV)

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS 19MA

SUMMARY 12

TOTAL TRUCK CARGO EXPORTED (UNITS OF 13 LONGTON)

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD	3132
MAXIMUM	211 (ON DAY 14c AT 1258)
AVERAGE	136.40
MINIMUM	0 (ON DAY 0 AT 0 0)

NUMBER	PERCENT OF REPORT PERIOD
0	0.2
1 THRU 100	11.1
101 THRU 200	27.8
201 THRU 300	0.9
301 THRU 400	0.0
401 THRU 500	0.0
501 THRU 600	0.0
601 THRU 700	0.0
701 THRU 800	0.0
801 THRU 900	0.0
901 THRU 1000	0.0
OVER 1000	0.0

Figure 52 - TOTAL TRUCK CARGO EXPORTED (SIM. IV)

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS 19

SUMMARY 13

TOTAL RAIL CARGO EXPORTED (UNITS OF 540 LONGTENS)

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD 1026

MAXIMUM 45 (ON DAY 7 AT 2052,
AND 1 OTHER TIMES)

AVERAGE 24.94

MINIMUM 0 (ON DAY 0 AT 0 0)

NUMBER	PERCENT OF REPORT PERIOD
0	0.6
1 THRU 100	99.4
101 THRU 200	0.0
201 THRU 300	0.0
301 THRU 400	0.0
401 THRU 500	0.0
501 THRU 600	0.0
601 THRU 700	0.0
701 THRU 800	0.0
801 THRU 900	0.0
901 THRU 1000	0.0
OVER 1000	0.0

Figure 53 - TOTAL RAIL CARGO EXPORTED (SIM. IV)

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS

19MAY

SUMMARY 15

SHIP TIME AT ALL BERTHS (ALL SHIPS)

ELAPSED TIME (INCLUDING DELAYS)

TOTAL TIME 25159 HRS 40 MIN 12 SEC
 MAXIMUM TIME 236 HRS 20 MIN 26 SEC (OCCURRED ON DAY 144,
 BEGINNING AT TIME 126)
 AVERAGE TIME 198 HRS 6 MIN 27 SEC
 MINIMUM TIME 106 HRS 24 MIN 16 SEC (OCCURRED ON DAY 17,
 BEGINNING AT TIME 1320)

HRS	MIN	SEC		HRS	MIN	SEC	FREQUENCY	PER CENT
96	0	0	OR LESS				0	0.0
96	0	0	THRU	108	0	0	2	1.6
108	0	0	THRU	120	0	0	6	4.7
120	0	0	THRU	132	0	0	0	0.0
132	0	0	THRU	144	0	0	0	0.0
144	0	0	THRU	156	0	0	2	1.6
156	0	0	THRU	168	0	0	2	1.6
168	0	0	THRU	180	0	0	4	3.1
180	0	0	THRU	192	0	0	10	7.9
192	0	0	THRU	204	0	0	39	30.7
204	0	0	THRU	216	0	0	38	29.9
216	0	0	THRU	228	0	0	20	15.7
228	0	0	THRU	240	0	0	4	3.1
240	0	0	THRU	252	0	0	0	0.0
252	0	0	THRU	264	0	0	0	0.0
264	0	0	THRU	276	0	0	0	0.0
276	0	0	THRU	288	0	0	0	0.0
			MORE THAN	238	0	0	0	0.0
TOTAL NUMBER							127	

Figure 54 - SHIP TIME AT ALL BERTHS (SIM. IV)

NWS CONCURRENT EXPORT CAPABILITY

SHINDO XIS

SHIP DELAY TIMES WAITING FOR PERTS

[illegible]

Figure 55 - SHIP DELAY TIMES (SIM. IV)

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS

SUMMARY 1

NUMBER OF VANS IN STORAGE AREA

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD 6569

MAXIMUM 150 (ON DAY 0 AT 8 0)

AVERAGE 55.23

MINIMUM 0 (ON DAY 0 AT 8 0,
AND 103 OTHER TIMES)

NUMBER PERCENT OF REPORT PERIOD

0	2.0
1 THRU 25	22.6
26 THRU 50	22.1
51 THRU 75	24.2
76 THRU 100	19.3
101 THRU 125	7.6
126 THRU 150	2.1
151 THRU 175	0.0
176 THRU 200	0.0
201 THRU 225	0.0
226 THRU 250	0.0
251 THRU 275	0.0
276 THRU 300	0.0
301 THRU 325	0.0
326 THRU 350	0.0
351 THRU 375	0.0
376 THRU 400	0.0
OVER 400	0.0

Figure 56 - NUMBER OF VANS IN STORAGE AREAS (SIM. IV)

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS 19MAY77

SUMMARY 2

NUMBER OF TRAINS (10 CARS PER TRAIN) AT STORAGE AREA

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD 2128

MAXIMUM 53 (ON DAY 0 AT 8 0)

AVERAGE 10.49

MINIMUM 0 (ON DAY 0 AT 8 0,
AND 187 OTHER TIMES)

NUMBER PERCENT OF REPORT PERIOD

0		30.6
1 THRU 5		15.6
6 THRU 10		13.5
11 THRU 15		10.8
16 THRU 20		10.1
21 THRU 25		6.9
26 THRU 30		4.7
31 THRU 35		3.3
36 THRU 40		2.7
41 THRU 45		0.3
46 THRU 50		0.6
51 THRU 55		0.0
56 THRU 60		0.0
61 THRU 65		0.0
66 THRU 70		0.0
71 THRU 75		0.0
76 THRU 80		0.0
81 THRU 85		0.0
86 THRU 90		0.0
91 THRU 95		0.0
96 THRU 100		0.0
OVER 100		0.0

Figure 58 - NUMBER OF TRAINS AT STORAGE AREA (SIM. IV)

SUMMARY 27

STORAGE TIMES OF RAILCARS

ELAPSED TIME (INCLUDING DELAYS)										DELAY TIME									
TOTAL TIME					45297 HRS 50 MIN 16 SEC					218 HRS 56 MIN 57 SEC					TOTAL DELAY				
MAXIMUM TIME					42 HRS 34 MIN 23 SEC					55 HRS 52 MIN 24 SEC					MAXIMUM DELAY				
AVERAGE TIME					0 HRS 0 MIN 0 SEC					0 HRS 0 MIN 0 SEC					AVERAGE DELAY				
MINIMUM TIME					0 HRS 0 MIN 0 SEC					0 HRS 0 MIN 0 SEC					MINIMUM DELAY				

APPENDIX I

RESULTS OF SIMULATION RUN V

Simulation run V was run attempting to achieve 80 percent berth occupancy. The vessel arrivals were Poisson distributed with a mean interarrival time of 42 hours in order to generate about 104 vessels in the 180 day period.

Train arrivals were given a distribution of no trains arriving 25 percent of the days, one train 50 percent of the days, and two trains arriving 25 percent of the days. Arriving trains had 50 cars 100 percent of the time. Therefore, on the average, 50 railcars arrived each day.

Truck arrivals were Poisson distributed with a mean interarrival time of 33 minutes during normal operations. When the number of vans in the storage area was less than 10, the mean interarrival time was 13 minutes and when the number of vans in the storage area was greater than 150, the mean interarrival time was 53 minutes. The average number of truck arrivals per eight hour receiving period was expected to be 14.5.

The results for simulation run V are shown in the accompanying figures and are summarized as follows:

- 1) Occupancy rate was $4.65/6 = 77.5$ percent.
- 2) Van cargo exported was $(2496)(18) = 44928$ long tons.
- 3) Rail cargo exported was $(840)(540) = 453600$ long tons.
- 4) Total cargo exported was $453600 + 44928 = 498,528$

long tons.

5) Number of vessels turned around was 97.

6) Percent of vessels delayed was $100 - 44.3 = 55.7$ percent.

7) Average/maximum number of vans in the storage area was $94.4/196$.

8) Average van storage time was about 153.9 hours.

9) Average/maximum number of railcars in the storage area was $900/1530$.

10) Average railcar storage time was about 404.9 hours.

NWS CCNCORD EXPORT CAPABILITY

SIX MONTHS 20MAY77

MARY 10

OCCUPANCY OF ALL BERTHS (TOTAL NUMBER OF SHIPS IN PCRT)

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD		97
MAXIMUM	6 (ON DAY	0 AT 8 0.
	AND 65 OTHER TIMES)	
AVERAGE	4.65	
MINIMUM	0 (ON DAY	0 AT 0 0)

NUMBER		PERCENT OF REPORT PERIOD
	0	0.2
1 THRU	1	1.9
2 THRU	2	12.0
3 THRU	3	16.8
4 THRU	4	7.6
5 THRU	5	10.7
6 THRU	6	50.9
OVER	6	0.0

Figure 60 - OCCUPANCY OF ALL BERTHS (SIM. V)

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS

20MAY

SUMMARY 12

TOTAL TRUCK CARGO EXPORTED (UNITS OF 18 LONGTON)

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD 2496

MAXIMUM 205 (ON DAY 26 AT 16 9)

AVERAGE 108.64

MINIMUM 0 (ON DAY 0 AT 0 0)

NUMBER	PERCENT OF REPORT PERIOD
0	0.2
1 THRU 100	42.7
101 THRU 200	57.0
201 THRU 300	0.1
301 THRU 400	0.0
401 THRU 500	0.0
501 THRU 600	0.0
601 THRU 700	0.0
701 THRU 800	0.0
801 THRU 900	0.0
901 THRU 1000	0.0
OVER 1000	0.0

Figure 61 - TOTAL TRUCK CARGO EXPORTED (SIM. V)

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS 20MAY77

SUMMARY 13

TOTAL RAIL CARGO EXPORTED (UNITS OF 540 LONGTONS)

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD 840

MAXIMUM 47 (ON DAY 23 AT 1227)

AVERAGE 21.67

MINIMUM 0 (ON DAY 0 AT 0 0)

NUMBER	PERCENT OF REPORT PERIOD
0	0.6
1 THRU 100	99.4
101 THRU 200	0.0
201 THRU 300	0.0
301 THRU 400	0.0
401 THRU 500	0.0
501 THRU 600	0.0
601 THRU 700	0.0
701 THRU 800	0.0
801 THRU 900	0.0
901 THRU 1000	0.0
OVER 1000	0.0

Figure 62 - TOTAL RAIL CARGO EXPORTED (SIM. V)

NWS CONCORD EXPORT CAPABILITY

SIX MONTHS

20MAY77

SUMMARY 15

SHIP TIME AT ALL BERTHS (ALL SHIPS)

ELAPSED TIME (INCLUDING DELAYS)

TOTAL TIME	19522 HRS 26 MIN 50 SEC	
MAXIMUM TIME	237 HRS 58 MIN 11 SEC	(OCCURRED ON DAY 17, BEGINNING AT TIME 7 9)
AVERAGE TIME	201 HRS 15 MIN 44 SEC	
MINIMUM TIME	108 HRS 44 MIN 27 SEC	(OCCURRED ON DAY 160, BEGINNING AT TIME 610)

HRS	MIN	SEC		HRS	MIN	SEC	FREQUENCY	PER CENT
96	0	0	OR LESS				0	0.0
96	0	0	THRU	108	0	0	0	0.0
108	0	0	THRU	120	0	0	5	5.2
120	0	0	THRU	132	0	0	0	0.0
132	0	0	THRU	144	0	0	0	0.0
144	0	0	THRU	156	0	0	1	1.0
156	0	0	THRU	168	0	0	0	0.0
168	0	0	THRU	180	0	0	4	4.1
180	0	0	THRU	192	0	0	9	9.3
192	0	0	THRU	204	0	0	27	27.8
204	0	0	THRU	216	0	0	28	28.9
216	0	0	THRU	228	0	0	21	21.6
228	0	0	THRU	240	0	0	2	2.1
240	0	0	THRU	252	0	0	0	0.0
252	0	0	THRU	264	0	0	0	0.0
264	0	0	THRU	276	0	0	0	0.0
276	0	0	THRU	288	0	0	0	0.0
			MORE THAN	288	0	0	0	0.0
TOTAL NUMBER							97	

Figure 63 - SHIP TIME AT ALL BERTHS (SIM. V)

NKS CONCORD EXPORT CAPABILITY SIX MONTHS

SUMMARY 14 SHIP DELAY TIMES WAITING FOR BERTHS

ELAPSED TIME (INCLUDING DELAYS)										DELAY TIME									
TOTAL TIME		4109 HRS	1 MIN	7 SEC	(OCCURRED ON DAY BEGINNING AT TIME 1125)		TOTAL DELAY		4109 HRS	1 MIN	7 SEC	(OCCURRED ON DAY BEGINNING AT TIME 1125)							
MAXIMUM TIME		128 HRS	51 MIN	32 SEC			MAXIMUM DELAY		128 HRS	51 MIN	32 SEC								
AVERAGE TIME		42 HRS	21 MIN	40 SEC	(OCCURRED ON DAY BEGINNING AT TIME 1321 AND 42 OTHER TIMES)		AVERAGE DELAY		76 HRS	5 MIN	35 SEC	(OCCURRED ON DAY BEGINNING AT TIME 2050)							
MINIMUM TIME		0 HRS	0 MIN	0 SEC			MINIMUM DELAY		2 HRS	40 MIN	48 SEC								
HRS	MIN	SEC	HRS	MIN	SEC	FREQUENCY	PER CENT	HRS	MIN	SEC	HRS	MIN	SEC	FREQUENCY	PER CENT				
0	0	0	0	0	0	43	44.3	0	0	0	0	0	0	0	0.0				
1	0	0	1	0	0	0	0.0	0	0	0	0	0	0	2	0.0				
2	0	0	2	0	0	0	0.0	2	0	0	0	0	0	0	0.0				
3	0	0	3	0	0	1	1.0	4	0	0	0	0	0	2	3.7				
4	0	0	4	0	0	0	0.0	6	0	0	0	0	0	0	0.0				
5	0	0	5	0	0	0	0.0	8	0	0	0	0	0	0	0.0				
6	0	0	6	0	0	2	2.1	10	0	0	0	0	0	0	0.0				
7	0	0	7	0	0	0	0.0	12	0	0	0	0	0	1	1.9				
8	0	0	8	0	0	0	0.0	14	0	0	0	0	0	1	1.9				
9	0	0	9	0	0	0	0.0	16	0	0	0	0	0	0	0.0				
10	0	0	10	0	0	0	0.0	18	0	0	0	0	0	1	1.9				
11	0	0	11	0	0	0	0.0	20	0	0	0	0	0	0	0.0				
12	0	0	12	0	0	0	0.0	22	0	0	0	0	0	1	1.9				
13	0	0	13	0	0	1	1.0	24	0	0	0	0	0	0	0.0				
14	0	0	14	0	0	0	0.0	26	0	0	0	0	0	2	3.7				
15	0	0	15	0	0	1	1.0	28	0	0	0	0	0	0	0.0				
16	0	0	16	0	0	0	0.0	30	0	0	0	0	0	0	0.0				
17	0	0	17	0	0	0	0.0	32	0	0	0	0	0	0	0.0				
18	0	0	18	0	0	0	0.0	34	0	0	0	0	0	0	0.0				
19	0	0	19	0	0	1	1.0	36	0	0	0	0	0	1	1.9				
20	0	0	20	0	0	0	0.0	38	0	0	0	0	0	0	0.0				
MORE		20	0	0	47		48.5	40	0	0	0	0	0	1	1.9				
		20	0	0				42	0	0	0	0	0	0	0.0				
								44	0	0	0	0	0	1	1.9				
								46	0	0	0	0	0	0	0.0				
								48	0	0	0	0	0	41	75.9				
								MORE THAN		48	0	0							
TOTAL NUMBER		97						NUMBER DELAYED				54							

SUMMARY 1

NUMBER OF VANS IN STORAGE AREA

~~TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE~~

TOTAL NUMBER IN REPORT PERIOD 5299

MAXIMUM 196 (ON DAY 104 AT 1559)

AVERAGE 94.42

MINIMUM 0 (ON DAY 0 AT 8 0,
AND 72 OTHER TIMES)~~NUMBER PERCENT OF REPORT PERIOD~~

	0	1.6
1 THRU	25	15.3
26 THRU	50	12.2
51 THRU	75	13.4
76 THRU	100	10.3
101 THRU	125	12.5
126 THRU	150	8.7
151 THRU	175	18.7
176 THRU	200	7.3
201 THRU	225	0.0
226 THRU	250	0.0
251 THRU	275	0.0
276 THRU	300	0.0
301 THRU	325	0.0
326 THRU	350	0.0
351 THRU	375	0.0
376 THRU	400	0.0
	OVER 400	0.0

Figure 65 - NUMBER OF VANS IN STORAGE AREAS (SIM. V)

SUMMARY 2

NUMBER OF TRAINS (10 CARS PER TRAIN) AT STORAGE AREA

TOTAL NUMBER IN SERVICE, DELAYED, OR IDLE

TOTAL NUMBER IN REPORT PERIOD	1747
MAXIMUM	153 (ON DAY 140 AT 8 0)
AVERAGE	90.00
MINIMUM	0 (ON DAY 0 AT 8 0, AND 1 OTHER TIMES)

NUMBER PERCENT OF REPORT PERIOD

0	0.0
1 THRU 5	0.0
6 THRU 10	0.0
11 THRU 15	0.0
16 THRU 20	0.0
21 THRU 25	0.2
26 THRU 30	1.5
31 THRU 35	6.6
36 THRU 40	6.7
41 THRU 45	6.0
46 THRU 50	3.0
51 THRU 55	2.5
56 THRU 60	3.0
61 THRU 65	2.8
66 THRU 70	2.7
71 THRU 75	4.4
76 THRU 80	2.1
81 THRU 85	3.1
86 THRU 90	5.7
91 THRU 95	5.4
96 THRU 100	1.1
OVER 100	43.2

Figure 67 - NUMBER OF TRAINS AT STORAGE AREA (SIM. V)

SUMMARY 27 STORAGE TIMES OF RAILCARS

ELAPSED TIME (INCLUDING DELAYS)										DELAY TIME									
TOTAL TIME 353485 HRS 41 MIN 15 SEC					(OCCURRED ON DAY 109. 8 0)					TOTAL DELAY 353485 HRS 41 MIN 15 SEC					(OCCURRED ON DAY 109. 8 0)				
MAXIMUM TIME 777 HRS 48 MIN 51 SEC										MAXIMUM DELAY 777 HRS 48 MIN 51 SEC									
AVERAGE TIME 404 HRS 54 MIN 32 SEC					(OCCURRED ON DAY 0. 5 OTHER TIMES)					AVERAGE DELAY 407 HRS 42 MIN 40. SEC					(OCCURRED ON DAY 0. 5 OTHER TIMES)				
MINIMUM TIME 0 HRS 0 MIN 0 SEC										MINIMUM DELAY 17 HRS 53 MIN 9 SEC									

Figure 68 - STORAGE TIMES OF RAILCARS (SIM. V)

APPENDIX J

VESSEL EXPORT TONNAGES IN CLASS GROUPINGS FOR JANUARY THROUGH JUNE 1968

This appendix is a representation of all vessels in each class, of the vessels that made complete turnarounds in the first six months of 1968, showing the relative distribution of vessel cargo tonnages within each class and the number of vessels in the class.

115

15

10

5

400

5.

3

17

5

9

2.

C.

10

ANALYSIS OF MODELS

THE UNIVERSITY OF CHICAGO

1005	4414	4343	3012	3391
9505	9814	5853	3022	1
4205	9814	6643		6541
2605	6224	4083		
2115	5434	8163		
5315	0424	4003		
2815	2054			
2025	5274			
2425	0494			
3035	3634			
4635	4694			
8045	9244			
0345	4664			
9445	4004			
2945				
1255				
4655				
0455				
1765				
0285				
2465				
1405				

3003 6003
2442 6442
3183 6183
2619 6619
1229 6229
6339 6639
3259 6259
8259 6825
1859 6859
0191 6019
3499 6499
9269 6926
6569 6656
0669 6669
2569 6256

0312
5622
5046
5617
6.856
8136

8163	10132
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WHEEL, CLAY:

Figure 69 - VESSEL EXPORT TONNAGES IN CLASS GROUPINGS FOR
JANUARY THROUGH JUNE 1968

APPENDIX K

THE TRIANGULAR DISTRIBUTION

The triangular distribution is a distribution made available to the users of TRANSIM. The upper and lower ranges of the event possibilities are defined to have zero probability. The only other significant point on the probability curve is at an arbitrary point between the upper and lower limits with an assigned probability. Connecting the three points forms a triangle, hence the name. The "curve" is just two connecting straight lines. The figure below gives an example of the triangular density function for the berth time distribution of a class 01 vessel used in this model.

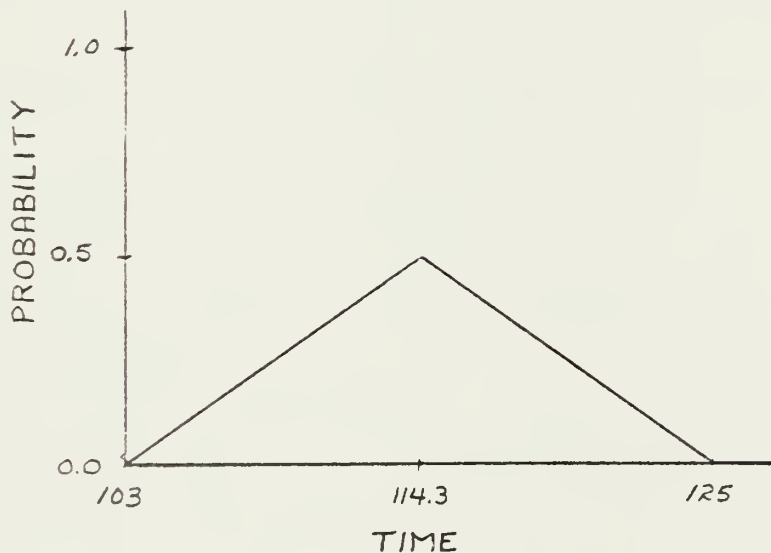


Figure 70 - A TRIANGULAR DISTRIBUTION

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3 JUN 92

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